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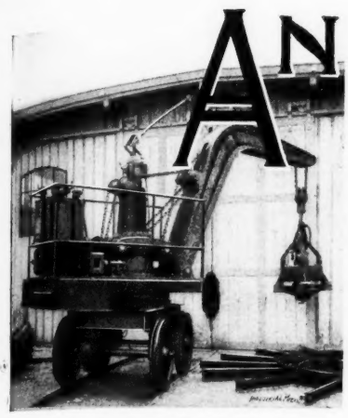
ELECTRICAL WORKS OF THE MASCHINENFABRIK OERLIKON.

SOME DETAILS OF THIS GREAT SWISS MANUFACTURING PLANT.

FRANK C. PERKINS.



AN interesting description of the works of the Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., was recently given in the columns of MACHINERY, with many illustrations, which give an excellent idea of one of the greatest American electrical manufacturing plants. It is the intention of the writer to give a similar description of the plant of one of the most prominent electrical manufacturing concerns abroad, whose work is typical of the best foreign shop practice.

The Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland, has a world-wide reputation, and this works is provided with the most modern machinery, illustrating the best practice in Europe.

Thirty years ago this plant was started, as a small foundry and shop for building small tools. Increasing business soon required a larger factory, and the construction of woodworking machinery was added to the output. The gradual growth continued until the seventeenth year, when the manufacture of machine tools took a prominent place in this establishment as well as the construction of war materials, and special machinery for millers' work. During the eighteenth year the firm commenced the manufacture of electrical machinery, being one of the pioneers in this industry, and it has worked itself into a prominent position in the field of heavy current apparatus. An additional plant was built for the combining of electrical motors with the various machine tools, including cranes, lathes, planers, shapers, drills and boring machines, all of the various types being used in the shops, in the different departments.

The buildings of the works of the Maschinenfabrik Oerlikon, seen in Fig. 1, cover an area of 402 acres, deducting the space occupied by workingmen's dwellings, while the total area is about 980 acres. The works are connected to the main tracks of the Nord-Ostbahn, by a line of standard gage as well as a narrow gage road, 5 kilometers (3.1 miles) long. Two electric locomotives are used as well as a portable crane car of the type shown in the sketch at the head of this article, for transferring castings, machines and materials from cars to various parts of the yards and for loading and unloading standard gage cars from narrow gage trucks.

For the different operations in this manufacturing plant, there are 770 machine tools of various dimensions and types, a large proportion of which are electrically driven. For the conveyance of materials, machine tools and castings from one part of the buildings to other parts, there are installed 19 electric cranes varying in sizes up to 30 tons capacity, of the Oerlikon type, which may be seen in operation in the illustration of the foundry, Fig. 4. There are also 47 hand-operated cranes in the various buildings about the works. To supply the necessary materials requires the continuous operation of

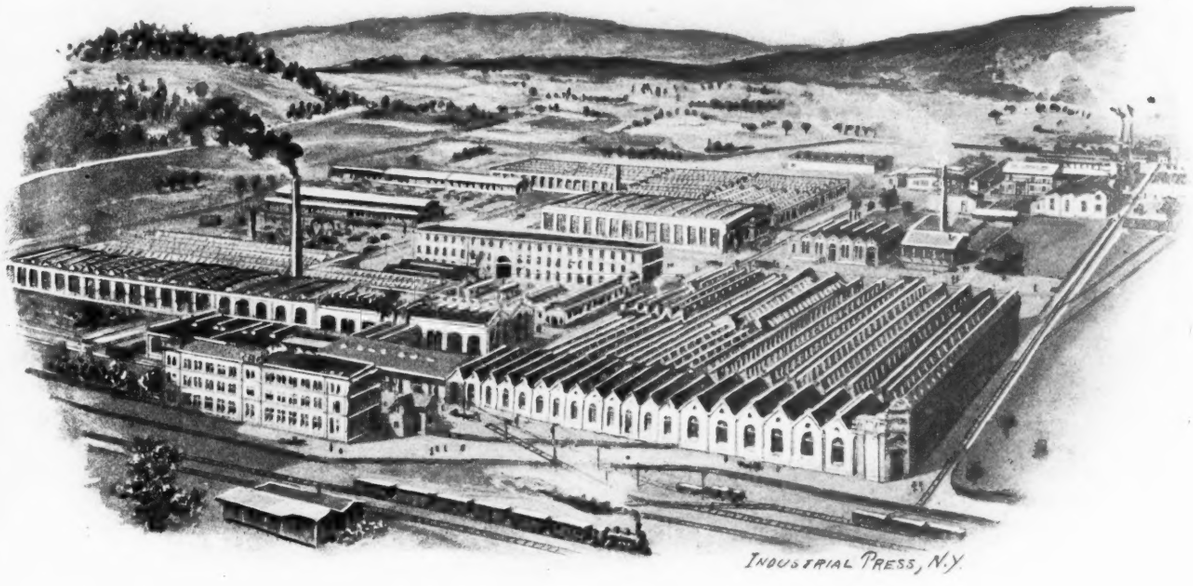


Fig. 1. Works of Oerlikon Maschinenfabrik, Zurich, Switzerland.

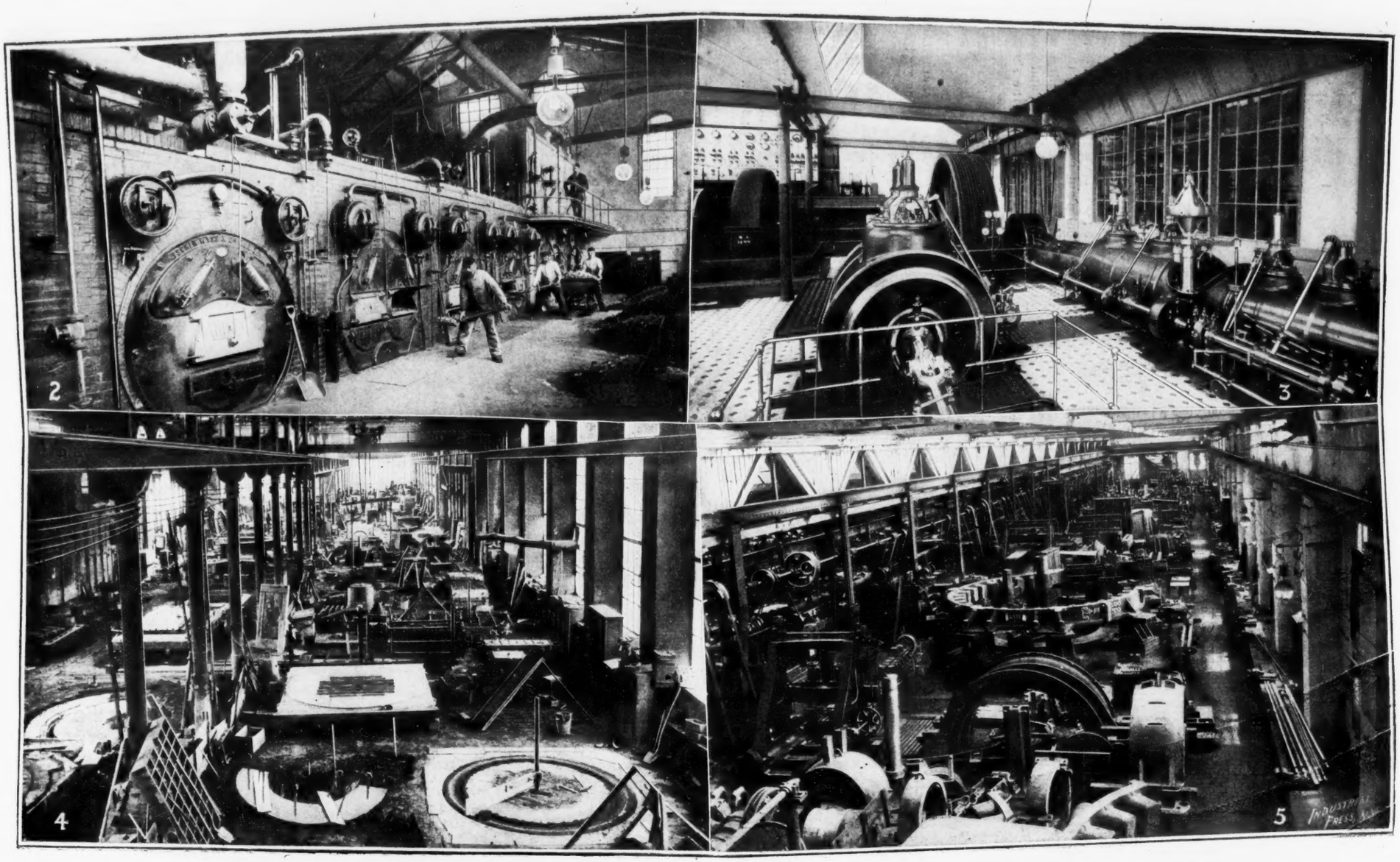


Fig. 2. Boiler Plant of Oerlikon Works. Four Cornwall Boilers in Foreground.
Fig. 4. Section of Foundry showing Electric Crane Tracks and Crane.

Fig. 3. Engine and Generator Room. Six Hundred H. P. Triple-expansion Engine.
Fig. 5. Electrically-driven Machine Tools working on Heavy Generator Frame supported on Floor-plate.

twelve foundry furnaces and forges. The electrically-driven machine tools are equipped with 181 polyphase motors, of which four are of the synchronous type and all of the others, asynchronous, excepting 10 direct-current machines.

Different methods of driving are used according to the class of machinery. Part of the tools are separately driven, and

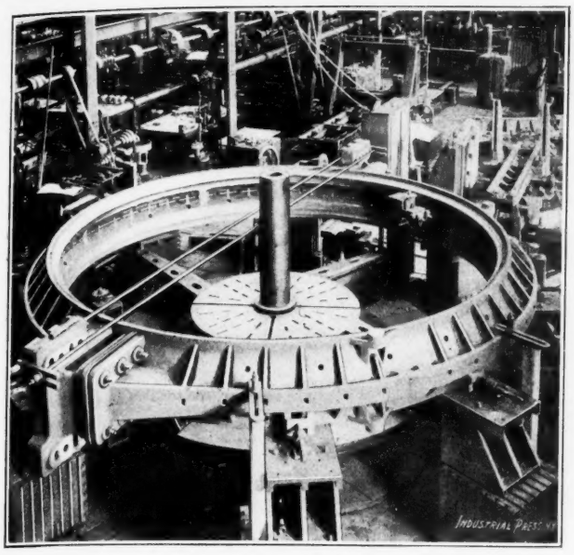


Fig. 6. Floor-plate Electrically-driven Machine Tools. Casting Mounted on Floor Plate and Tools on Revolving Spider.

part are operated in groups; while 17 portable electric motors are also employed, as noted in the group, in Fig. 12, for supplying the necessary power to many different machines, which may be located at any part of the shop desired, connections being made at junction boxes by cables unwound from the reel.

the case of the enormous lathe, Fig. 10, upon the faceplate of which is fastened a huge generator frame. It would be superfluous to enter into a detailed description of this machine, as it is so well illustrated.

There is a third class of machines for boring large field frames and similar work operated by motors placed under the floor. Instead of supporting the work on a rotating table and using fixed cutter bars, as in the case of the immense boring and turning mills at the Westinghouse shops, illustrated in the October MACHINERY, page 36, it is the practice here to have the work held stationary and the cutter bar rotate. In Fig. 6 is one type of these machines in which the work is bolted to a large floor plate and the arm carrying the cutting tool rotates on a vertical axis. A field frame is of such enormous size that when placed in a vertical position the upper part will sag an appreciable amount, and in boring this must be taken into account. If the frame is bored in a vertical position of course no provision need be made; but when bored in a horizontal position, as in Fig. 6, it is sprung slightly by bolts connecting the upper and lower parts of the frame, and the boring takes place while the casting is so sprung.

For boring a frame in a vertical position, a machine is used somewhat similar in principle to the vertical boring machine illustrated in the same article upon the Westinghouse works, in the October MACHINERY, page 37. The working parts consist of two sets of four radial arms mounted on a shaft, the whole forming a revolving frame which is shown in Fig. 8 resting on the shop floor. The lower half of an enormous alternator stationary armature is in place ready to receive the frame, which is supported in bearings on either side of the casting; after which the upper half of the frame is placed in position, ready for boring. The electric crane is here used to good advantage.

The rotating frame of this machine is driven by gearing from the motor beneath the floor, there being a large gear bolted to each set of arms for this purpose. The arms have flat finished surfaces provided with T-slots, to which brackets

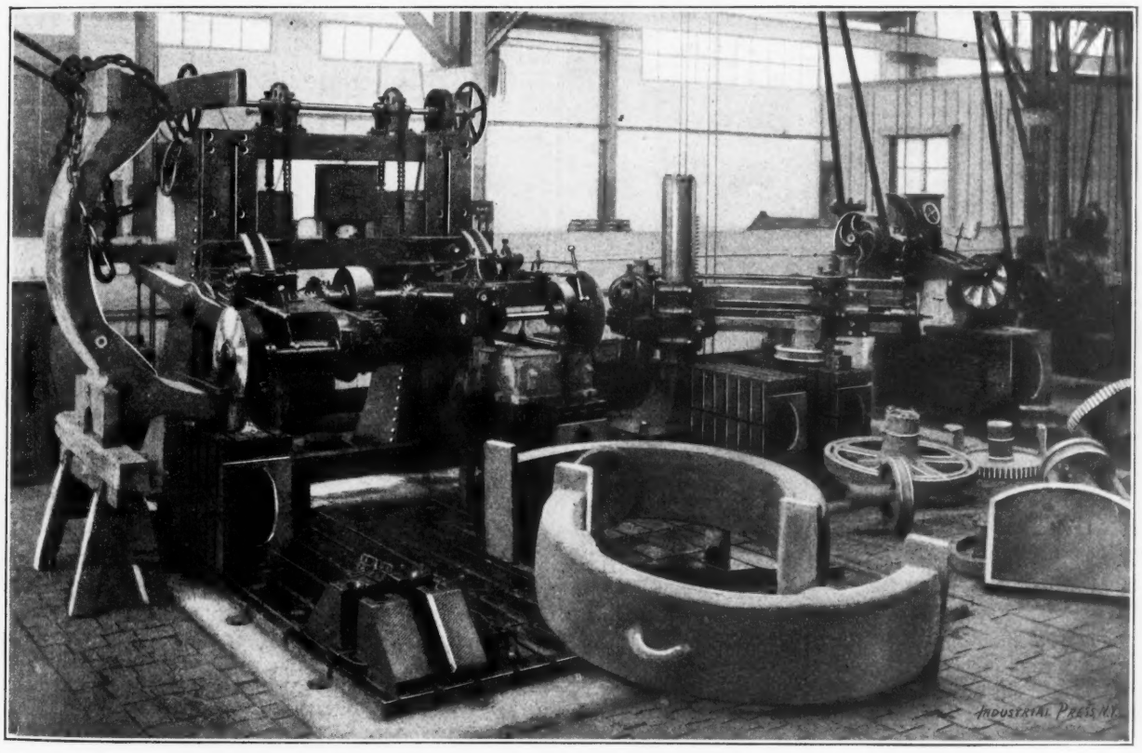


Fig. 7. Motor-driven Machines, Direct-connected. Motors Mounted on Shelves or Brackets on Frames of Machines. Three Types of Swinging-frame Metal Sawing Machines.

Some of the electric motors are mounted upon the tops of the machine tools, or on brackets and shelves, and are directly connected, without the use of belting, similar to those seen in Fig. 7. The current is supplied directly to the machines through underground cables. Others have the motors driving them located on the floor or on the same base as the machine, the power being transmitted by belting, as seen in

carrying cutting tools can be conveniently bolted. In Fig. 9 the machine is shown at work upon a heavy field magnet flywheel. The rotating frame is in place in its bearings and the flywheel is carried by the shaft which supports the frame and rotates with the frame. The wheel was machined by mounting a slide rest on a support bolted to the floor plate at the front of the machine and when the photograph was taken a drilling

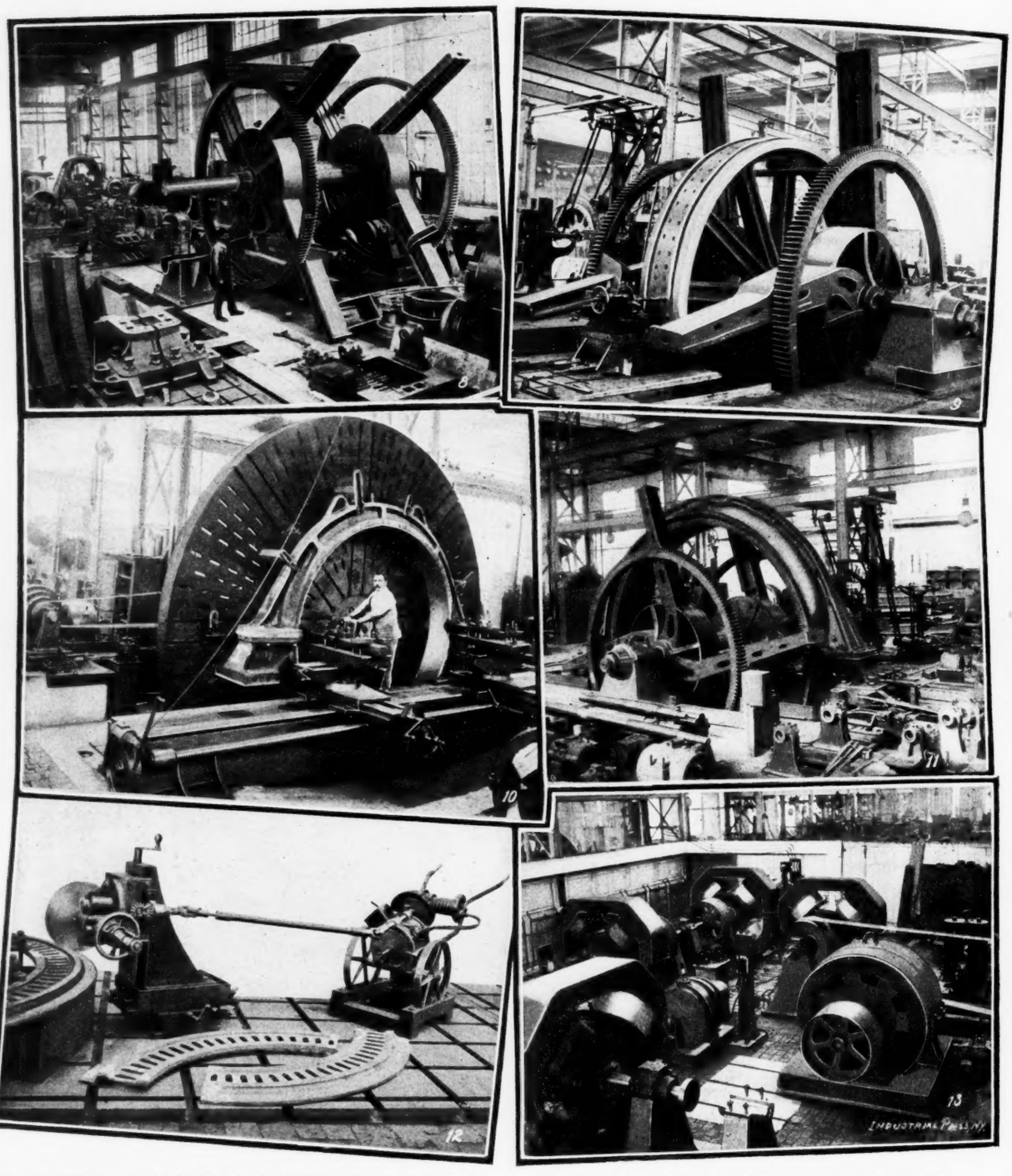


Fig. 8. Gruben-Krenz Boring Machine before being placed on its Bearings.
Fig. 10. Electrically-operated Lathe. Separate Motor Belt-driven.
Fig. 12. Portable Electric Motor for operating Machine Tools.

Fig. 9. Boring Machine working on Heavy Field Magnet Wheel.
Fig. 11. Boring Machine working on Stationary Armature.
Fig. 13. Experimental and Testing Department.

fixture mounted on this same support was being used to drill a series of radial holes in the rim of the wheel. This shows the wide range of work to which a machine of this type can be adapted. It will be noted that the flywheel is driven by the very simple means of passing a steel rail between the spokes of the wheel and bolting each end of the rail to one of the arms of the frame.

Fig. 11 shows the same machine in operation upon the generator frame and the controlling rheostat and starting box of the motor are to be seen in front near the main bearing.

In certain parts of a factory where small tools are used, and frequently a number of them requiring in all but a small amount of power, it is generally conceded that a single motor can be used to advantage in each of such rooms, driving a short line shaft, or if more than one line of shafting is necessary, a motor for each transmission. There are two such rooms at the Oerlikon works, with single polyphase motors for each line of shafting, mounted upon brackets and shelves on the end walls of the rooms near the ceilings, and transmitting the necessary power by belting. In these rooms small parts, such as brush holders, are made, and punching machines are used for punching out armature disks.

One of the most important departments of any manufacturing plant should be its experimental shop, for testing the output of the factory to see that every machine tool, electrically-driven or mechanically-driven, is perfect in every way; also for testing its capacity, for determining its efficiency and the necessary amount of power required to drive it. These figures should be exactly given and marked upon the shipping tags. Such an experimental room is shown in Fig. 13, and this is where the necessary power is determined, temperature rise of the machine tool motors found out, and efficiency of motors and dynamos tested.

Before closing it may be of interest to give a short de-

scription of the power plant. It has in reality two central power stations, one supplying current from a steam-driven plant at the works, and the other located at Hochfelden, 22 kilometers distant, where a hydraulic electric power plant has been in operation some time, furnishing the necessary current by vertically driven generators for operating a large proportion of the machinery at the Oerlikon Works. The necessary water for driving the turbines is supplied by a tributary of the River Rhine known as the Glattflusse, which is an outlet of the Greifensee near Zurich, Switzerland. The water is conducted from a large dam at Hochfelden, a distance of 2.5 kilometers, to the turbines which operate under a head of 11 meters, the maximum flow of water being 5,000 liters per second. Each of the turbines has a capacity of 275 H. P., and each is directly connected to a Drehstrom generator having a vertically revolving shaft. The voltage of these generators is 58 volts and the speed, 180 revolutions per minute. There are two exciting direct-current generators, each directly connected to its own turbine and each capable of supplying the entire excitation current required by the alternators. Three step-up transformers are used, with a ratio of 1:154, raising the voltage of the alternators at 58 volts to a high tension line potential of 15,500 volts. After this polyphase current is transmitted over the transmission line 22 kilometers long at this high potential. Step-down transformers are installed at the Oerlikon Works, having a ratio of 53.3:1, the tension being reduced from 15,000 volts to 135-140 volts, at which pressure it is conducted through cables to the various motors about the works, including the electrically-operated cranes. These cranes are equipped with three-phase alternating current motors, 3 trolley wires or conductor rods being used with the three necessary contact devices upon the cranes.

The high-tension conductor coils of the transformers at Oerlikon consist of 2,772 turns of copper wire 3.3 to 3.7 millimeters in diameter, and the winding is connected in 11 sections, each of which has 252 turns. The three coils have a total weight of 800 kilogrammes, and a total length of wire of 3,500 meters is used in construction. The low tension coils are simpler, two being used for each phase connected in series. Each coil has 52 turns consisting of 10 copper conductors in parallel of 7.3 to 7.8 millimeters section.

It became necessary as the output increased to install a steam power plant, and eight steam engines were installed ranging from 45 H. P. to 600 H. P., with a total additional capacity of 1,220 H. P. The necessary steam supply was obtained by a boiler plant, seen in Fig. 2, consisting of six boilers, including four Cornwall boilers, two of which have a heating surface of 75 square meters (807.3 square feet) and the remaining two 65 square meters (699.6 square feet) and 100 square meters (1,076.4 square feet). Three of the boilers operate at a steam pressure of 6 atmospheres (88.2 pounds), and the last at 10 atmospheres (147 pounds). In addition to the above there are two larger boilers seen in the background in the illustration, each of which has a heating surface of 160 square meters and operating under a pressure of 11.5 atmospheres.

The boiler plant is equipped with Green economizers having 144 tubes 2,750 millimeters long and 115 millimeters in diameter. These are arranged in two groups, each of twelve elements consisting of six tubes each. Worthington pumps are used for feeding the boilers. The chimney is 36 meters high, and has a diameter of 3 meters.

The engine and generator room is shown with its switchboard equipment in Fig. 3. The 600 H. P. triple-expansion horizontal engine, constructed by Sulzer, is of the condensing type, and operates at a pressure of 11 atmospheres (161.7 pounds). The speed of the engine is 94 revolutions per minute. It drives a three-phase Oerlikon generator supplying in each phase a current of 1,500 amperes, the potential being 135 volts. The 200 H. P. horizontal engine, of the Sulzer compound type, with a speed of 65 revolutions per minute, operates a large three-phase Oerlikon alternator, and the exciting current for the fields of these alternating-current generators is obtained by dynamos directly connected to the vertical compound engine seen at the left in illustration, Fig 3. These machines operate at 900 revolutions per minute and supply a continuous exciting current of 70 amperes at 125 volts.

The current for lighting the entire works is supplied by direct-current machines, 135 volts being the potential at the switchboard and 125 volts at the lamps. There are 1,400 incandescent lamps used, of 16 c. p. each, and 286 arc lamps, each pair of the latter being connected in series. The 100 H. P. engine opposite the switchboard has directly connected to it on either side a continuous current dynamo, these two generators being connected in series. Several other units are also installed and in operation, the large number of units being largely due to the gradual growth of this great engineering plant. The annual output from the foundries of this establishment in the way of cast iron and cast steel is said to be more than three million kilogrammes (3,300 tons).

* * *

NOTES ON CURRENT TOPICS.

JAMES VOSE.

Among the tendencies of the last year or two in the district of Manchester, England, may be noted the growing popularity of vertical boring and turning mills and disk grinders. Among local tool builders who have recently made rather a specialty of this work may be mentioned Messrs. Smith & Coventry, Geo. Richards & Co., Ltd., and John Hetherington & Son, Ltd., in the larger sizes, and Roberts Bros. in the smaller. Further afield are J. Butler & Co., of Halifax, and Webster & Bennett, of Coventry. Messrs. Cunliffe & Croom, Ltd., and Roberts Bros. also manufacture some disk grinding machines which appear likely to find a special field of usefulness in the manufacture of textile machinery, a large number of small brackets and details used therein lending themselves admirably to this method of finishing. The output of the machine is found to compare extremely favorably with that of highly-specialized manual labor, and much more appears likely to be heard of this branch of tool development. The general utility of the horizontal boring machine is also obtaining rapid recognition, and Geo. Richards & Co., Ltd., Manchester, are assisting the process by the remodeling of their Nos. 1 and 2 machines. These tools are now made with two back-gear ratios, which, by the use of the two-speed countershaft, give 24 speeds to the spindle; positive feed with six quick changes, on Hendey-Norton lines; power rise and fall of the table; considerable traverse of spindle and great handiness in general, at a price calculated to encourage inquiries. Working in harmony with the Richards Tool Co., of London, they are also producing side planers embracing many improvements in general design and detail. The increasing desirability, in the case of heavy work, of bringing the tool to the work, in place of the reverse process, is not escaping the notice of tool builders here. The Atlas Engineering Co., Manchester, have recently devoted special attention to this branch.

Another local development is the placing on the market by Mr. John Tangye, who has had considerable experience in this class of work, of a line of rotary planers. One size, which he first built to suit the writer's requirements, has met with a good reception at the hands of users. We must confess to a distaste to setting work on a vertical surface, and a swiveling angle plate vise was designed for this machine to obviate the necessity of such, which answers its purpose very well. The proper supporting of slender flat work during machining is of considerable importance, and this is accomplished by the provision of numerous easily adjustable supporting points and special down-nip jaw dogs. The tool will machine a surface 30 by 11 inches, and on suitable work will show a time saving of 50 to 75 per cent. An efficient friction feed capable of fractional variations within wide limits is a feature of the machine. Self-hardening steel cutters of a section giving suitable rake and clearance and individually adjustable are used, and by removing two of the cutters while roughing out and replacing them so they will project slightly further than the roughing cutters for the finishing cut a very smooth finish may be produced. Personally, we find the plan of taking, say, three cuts at the coarsest traverse (say, 5-16 inch) better than taking only one or two with a finer traverse. A demand having arisen for this type of machine arranged by means of a hollow spindle, bored to Brown & Sharpe taper, and a removable supporting arm, to act as a

plain milling machine, Mr. Tangye is producing an interesting line fulfilling these conditions, and also larger sizes designed to surface areas 24 inches by any length.

The British Westinghouse Co's new works at Trafford Park are now on the point of completion and are rousing much interest, the fact of their being intended to be worked "on American lines" causing some speculation as to the ultimate effects of such action on the points of view of British employers and workpeople. For our own part, we fancy the effect will be almost wholly good, as there appears little of mystery in the reasons for American success in many industrial matters. The Americans have simply known exactly what they wished to do, and have gone the most direct way they could find to accomplish it. They are seldom impeded by the peddling modes of thought engendered in the case of some British firms by a gradual rise from very small beginnings. Trafford Park which covers a large area contiguous to the Manchester Ship Canal, and connected to the main railway systems of Great Britain, promises to become a very considerable center of engineering, especially of those branches bearing on electrical developments. Altogether the rapid expansion of engineering industries in the Manchester district is in itself sufficient answer to any pessimists in our midst who fancy the success of any other country in any line a direct menace to our own prosperity, as though any country could be enriched by the permanent downfall of its customers. The fiscal policy of the United States, by which it apparently endeavors to sell to this country without affording us the opportunity of return trade on an equitable basis, is arousing a sense of resentment, as the States by keeping up their practically prohibitive duties seem to give the lie to their assertion that they are able to compete with the rest of the world in manufactures in general. The British people do not wish to impose retaliatory duties. All they ask is "a fair field and no favor."

* * *

RECEIPT FOR SILVER METAL.

A writer in the *Aluminum World* gives the constituents of a hard alloy which has been found very useful for the operating levers of certain machines. The spacing lever of a typewriter is constantly handled when in use and if made of iron or steel and nickel-plated, even heavily, the plating soon wears off, leaving the metal underneath exposed to rust and corrosion, a condition which, of course, is not permissible. If the levers are made of brass the matter is not helped to any extent, as the plating wears off the same as iron or steel and leaves the brass exposed which is, if anything, more objectionable than iron or steel. The metal now generally used for this purpose by the various typewriter companies is "aluminum silver," or "silver metal." The proportions are given as follows:

Copper	57.00
Nickel	20.00
Zinc	20.00
Aluminum	3.00
	100.00

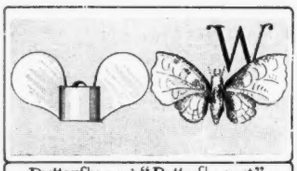
This alloy when used on typewriting machines is nickel-plated for the sake of the first appearance, but so far as corrosion is concerned, nickeling is unnecessary. In regard to its other qualities, they are of a character that recommends the alloy for many purposes. It is stiff and strong and cannot be bent to any extent without breaking, especially if the percentage of aluminum is increased to 3.5 per cent; it casts free from pinholes and blowholes; the liquid metal completely fills the mold, giving sharp, clean castings, true to pattern; its cost is not greater than brass; its color is silver white; and its hardness makes it susceptible of a high polish.

* * *

Knife grinding extraordinary is that done by the special grinding machines made by the Bridgeport Safety Emery Wheel Co. The largest knife grinding machines built by this company grind knives 170 inches long for "gulleting" machines used in tin and sheet metal mills for shearing thin metal plates. These machines are largely used in the sheet metal mills in the vicinity of Pittsburg, Pa.

WORKSHOP WORDS AND THEIR ORIGIN.

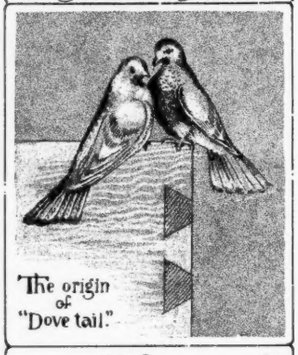
W. H. SARGENT.



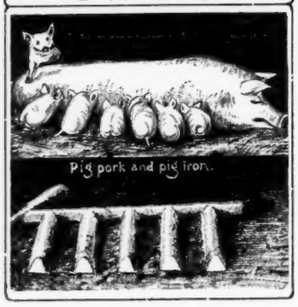
Butterfly and "Butterfly nut"

"Snibel" and Snipe bill.

Alligator and Alligator wrench



"Shop Hands"



AMBA, the jester in "Ivanhoe," calls attention to the fact that the names of live stock are Saxon so long as they require care or represent labor, but when dressed for the table they are called by aristocratic Norman or fashionable French names. Even in our own time the same distinction may be traced. The short, strong, direct work-a-day words are Saxon, as "anvil," "sledge," "saw," "lathe," "nail," "spade" and "plow." These are a part of the vocabulary of the working class, while the newer words like "bicycle," "automobile" and "telephone" belong to people of leisure who have time enough to pronounce long names of Latin origin. When these words come to be used for what they represent rather than for their scientific accuracy they are shortened to "bike," "mobile" and "'phone." The many-syllabled words are usually built up out of parts of other foreign words so as to accurately describe the distinctive features of the object. "Locomotive," for instance, coming from the Latin locus, place, and motum, to move; "safety valve" is from the Latin salvus or French sauf (safe) and valvus, a leaf; "gas" is from the German geist, to blow, and because of its airy and unsubstantial character we have our word "ghost" from the same root.

The Romans spoke of "ironing a horse" instead of shoeing, much as we now say "ironing a carriage," and as ferrum was the Latin for iron we come to have "farrier" for horseshoer. And speaking of horseshoer, what a volume of history, what a record of progress is locked up in the word "marshal," the commander-in-chief of the French army, since he, too, was once but a maréchal or horseshoer!

There are histories, as well as sermons, in stones. The ancients used small pebbles as an aid in counting and performing other arithmetical operations. These stones were called calculi, from whence naturally comes our word "calculate." The word "scale" (weighing machine) is unique in that the word comes down to us through two distinct channels, entirely unconnected. The Anglo-Saxons weighed in an even balance, using clam shells for pans. These shells they called "scalu" and the balance, in course of time, came to be called a "scale." The Romans improved upon this primitive balance by adding a sliding poise and by graduating the steel-yard into "scala"; that is, steps or divisions. Thus the

word "scale" came to be applied to any graduated scale, either of measurement or of weight, and finally for the second time the weighing machine itself was called a "scale."

The word "templet," or more properly "template," is from the Latin templatus, vaulted, since the masons, then as now, used a wooden form or "template" for laying the arches in a vault. Gradually the name came to mean any form used in laying out or constructing work. Eccentric is straight Latin, being from ex, out of, and centrum, center, "off center."

Petroleum is from petra, rock, and oleum, oil, and tells its own story very neatly.

Conversely "manufactured" originally meant "hand made," and has since changed about so that it now means almost the opposite, because certainly no large part of the "manufactured"products of to-day are "hand made." We still speak of a shop as employing so many "hands," although we mean, of course, that not only the workman's hands are utilized, but his arms and legs, his eyesight, his brain and all his faculties of mind and body. Other familiar words have completely changed in meaning. "Crafty" formerly meant having a craft or trade. "Villain" was once one who lived in a village. "Rubbish" was the refuse which had been rubbed off and thrown away. "Lumber" takes us back to the time when the Lombards did a general mercantile and banking business all over Europe, a "lumber yard" or Lombard yard being the place where their goods were stored.

The "haft" of a knife is the part by which we have to hold it. A "tinker's dam" has not the profane meaning sometimes attached to it, since it once meant a dam of bread or putty around the work which the tinker was soldering, the same as the plumber of to-day forms a mold around cast iron pipe when running a lead joint. A thing is, therefore, "not worth a tinker's dam" when it is of no more value than this cast-off form or mold which has been used and thrown away.

Many names are given because of the resemblance between the article and some object with which we happen to be familiar. In "dovetail," "bull's-eye" and "butterfly nut" the resemblance is so marked as to need no comment. A "spider" looks the part. A "ram" was born to push and bunt, and the Romans carved the prows of their boats and poles of their chariots to resemble the head and horns of a ram. A "snibel," or snipe bill, is a term sometimes used by blacksmiths to denote a swivel nut and hook. An "alligator wrench" so resembles the toothed and gaping mouth of the alligator that the name seems appropriately applied. This reptile, in turn, received his name from the Spaniards, who, when they first saw one, exclaimed "el lagarto"—"the lizard." Some English sailors who were on board adopted the word, which they mispronounced "alligator," and the hideous reptile has since borne this name.

"Pig iron" used to be molded in the sand in short fat bars a few inches apart, all attached to a main runner or "sow" from which they derived their supply until filled. In this condition they presented more than a fancied resemblance to a litter of sucking pigs attached to the mother sow. The suggestion was too evident to be overlooked and the name "pig iron" was applied and will doubtless always cling to iron in this form, although it is now cast rapidly by elaborately designed machinery with no suggestion of the pig-pen.

Many people received their name from the trade or calling with which they were connected. "Jenner" was once a joiner. "Webster" was one who made webs; that is, a weaver. "Currier" was once a worker in cuir, or leather. The old joke has it that the "Smiths" were all produced by the "Smith Manufacturing Co.," but older than this is the fact that the "smith" was one who smiteth, a goldsmith or silversmith being one who beats or smites the metal with the hammer.

There is a record of invention and a history of commerce locked up in the words which are derived from the names of places or of people. "Copper" derives its name from the island of Cyprus, once so rich in mines of this valuable metal. "Magnet" has its name from the deposits of iron ore in Magnesia, Asia Minor. "Tramway" recalls the name of its inventor, Outram, and "galvanism" perpetuates the memory of its discoverer, Galvani. "Maximite" is not so named because it is the maximum or greatest of all explosives, but rather because its inventor bore the name of Maxim. These studies into the origin of names should teach us the value of the correct use of words. A "smokestack" is a chimney or stack of brick or other masonry for conducting smoke. Any metal pipe for this purpose is properly, therefore, a smoke pipe and not a smokestack. The latter is, however, in such common use and its meaning is so evident that it is usually accepted without criticism. We speak of a "bevel" as being any angle whatever, but properly it is any angle other than 45 or 90 degrees. A "dock" is an enclosure into which a vessel is received and not the surrounding piling or wharfing. To speak of "falling off a dock" is equivalent to saying "falling off a hole!"

A "pair of scales" is incorrect, since only one is meant. A "pair of calipers" is a corruption of a pair of calibers, but is now in such common use that the original form is obsolete. We have used "rosin" for "resin," "shear" for "shore," "spile" for "pile" until both are in common use, and who shall say that one is not as correct as the other?

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THE OLDEST STEAM ENGINE NOW AT WORK.

Last summer, much to one's surprise, while at the Glasgow Congress of Engineering, and directed by the excellent handbook prepared for the guidance of members of the Congress, a real live Newcomen engine was discovered at a colliery at Rutherglen, near Glasgow. It is almost certainly the oldest engine now at work and is really a quite remarkable case of the survival of the unfittest.

A few years ago an engine of James Watt's manufacture, with sun and planet wheel complete, was taken down at a London brewery. It had been continuously working for 102 years, and was not at all decrepit when dismounted. It now forms an archæological exhibit in the museum of Sydney University. But this engine, though interesting and of about the same age as the Glasgow Newcomen, was of a comparatively modern type. It did not represent an extinct race.

The Newcomen engine at Farme Colliery, Rutherglen, was built in 1809, and has worked continuously to the present time. As it was constructed long after Watt's invention of the separate condenser, it may, perhaps, be inferred that one object in its design was to escape payment of royalty. Curiously enough, unlike all other Newcomen engines of which there is record, it is a winding, not a pumping engine. The cylinder is of pure Newcomen type, but there is a modified Watt parallel motion with the radius bar above the beam, and a crank and flywheel of comparatively modern type.

The cylinder is 3½ feet in diameter, and the stroke 6 feet. It takes about thirty-five seconds to raise coal from the bottom of the pit to the ground level. The cylinder was never bored, but it has now a beautiful internal surface, having worn out probably a thousand packings. The piston is packed with hemp gasket, and carries a layer of water on top, which makes it quite steam tight. There is no automatic valve gear. A single handle, worked by a man, opens alternately the steam and injection valves. There is no air pump. Gravity and the pressure of the incoming steam drive out the condensed steam and injection water through a flap foot-valve. It is stated that except brasses and one or two spur wheels, broken by accident, no important part of the engine has been renewed since it was built.

The beam is about 17 feet long and the flywheel is 15 feet in diameter. There is a feed-pump worked from the beam. The latter is carried on a masonry pier. The engine works quite smoothly and well, and, strange as it may seem, it is probably, for the intermittent work it is doing, not so extravagantly wasteful as might be supposed.—W. C. Unwin, in Cassier's Magazine for March.

* * *

H. T. Potter, Leonardsville, O., writes: "I noticed MACHINERY described an axle oiling device in a recent number, in which the axle was oiled by means of radial holes in the axle connecting with a longitudinal hole, into which oil was forced at the outer end of the axle by an oil pump. We have used compression grease cups screwed into the hub of the wheel and use 'hard oil' or axle grease with good satisfaction. The holes do not gum up nor does the grease run off when this method is used."

ELECTRICALLY-DRIVEN MACHINE TOOLS.—4.

PLANERS DRIVEN BY MOTORS—THE PROBLEMS ENCOUNTERED.

A. L. De Leeuw.

Planing machines form a class entirely different from the machines treated so far. In boring machines, either the work or the tool has a continuous rotating motion; in planing machines, the work or the tool has a reciprocating motion, and, in most cases, alternately at a higher and a lower speed. Various methods are used for producing this motion. In most pillar shapers, for instance, the required motion of the tool is produced by a shaft running continuously in one direction, and acting on a pivoted lever. In a great many traveling-head shapers, and also in most slotters, this motion is produced by what is known as Whitworth's quick return; but in the great majority of cases, namely, in planers and large slotters, the desired result is obtained by shifting belts. Where a shaper or crank slotter is to be driven electrically the problem becomes a simple one, because all that is necessary is to substitute a motor for the motive power, which otherwise drives the continuously running shaft. Of course this problem is perhaps not so easy to solve; but what I mean is this, that there are no difficulties beyond those mentioned in my previous articles. A small pillar shaper, for instance, is generally driven by a cone pulley with three or four steps, and no back gearing, so that the speed variation in such a machine is not very large, and a variable speed motor with a moderate range of speeds will be all that is required. The same is true about the smaller traveling-head shapers and the smaller slotters. In the larger machines of these classes, back gears are used; but the cone ratio is generally not very large, and here again a motor with a moderate speed range would do. It is easy to understand why this should be so. Take, for instance, an 18-inch shaper. The longest stroke, of course, is 18 inches. The shortest stroke, which one would expect to use, is certainly not less than 3 inches, which gives a range of six to one. Add to this 66 per cent for variations in speed, due to difference in hardness of material to be cut, and you get a total speed range of ten to one. One can get this by taking a motor with a speed range of three to one, and a back gear ratio of three and a third to one. Of course, as I stated before, it is sometimes pretty hard to get this range of three to one in a motor; and we will have to fall back on some mechanical device for supplying this speed range. Of such devices, I have already mentioned two sets of back gears, sliding gears, change gears (and combinations of all these), and variable speed countershafts. Other devices, applicable to the smaller machine tools, are pull pin gears, a cone of gears (such as used for the feed of a Hendey-Norton lathe), and various so-called speed controllers which are in the market. As the problem of the electric drive of such machine tools is not essentially different from the problems treated so far, we may dismiss the smaller shapers and slotters and proceed at once to those planing machines which are driven by shifting belts.

Every mechanic is, of course, familiar with the planer. In fact, I am almost afraid that most of them are so very familiar with this machine that they fail to notice some of its most peculiar features. The ordinary, present day planer acts by moving the work against the tool. It therefore has a platen, or table, capable of sustaining heavy loads, and of having these loads clamped down to it without springing or distorting to an appreciable extent. It follows that this table must be of heavy section, and therefore of great weight per foot length; besides, most planers are made long enough to plane long work, or sometimes a great number of shorter pieces. The weight of table and work together is often very considerable, and this weight has to be moved against sliding friction, both while doing work and while reversing. To show what a large factor this weight is, in the power required for a planer, I will take an example of an actual planer which I have seen at work many a time. This planer will plane work 12 feet wide, 10 feet high, and 30 feet long. It has four heads, two on the cross rail and one on each housing. The table weighs about 65,000 pounds, and I have seen it at work with a load of 80,000 pounds. This planer has a cutting speed of 20 feet and a return speed of 50 feet per minute. Now suppose the coefficient of friction of the table upon its ways to be 10 per cent (it may be higher with poor lubrication), then the pull required to move this table is $(65{,}000 + 80{,}000) : 10 = 14{,}500$ pounds. Suppose, further, that all four tools are at work, each requiring, say 8,000 pounds pull—which, by the way, is pretty heavy cutting—then the pull required on the cutting stroke is $14{,}500 + (4 \times 8{,}000) = 46{,}500$ pounds, and on the return stroke only 14,500 pounds. As the table moves 20 feet per minute on its cutting stroke, the power required on that stroke is $46{,}500 \times 20 = 930{,}000$ foot pounds per minute, or about 28 H. P. As the table moves 50 feet per minute on its return stroke, the power required when returning is $14{,}500 \times 50 = 725{,}000$ foot pounds per minute, or about 22 H. P. It must seem strange that this planer requires almost as much power to reverse as when doing very heavy duty, but experience shows this to be the case. If this planer had been doing light work, say finishing a piece with one tool, requiring perhaps 2,000 pounds pressure, the power required for reversing would still have been 22 H. P.; but the power required for cutting would have been only $(14{,}500 + 2{,}000) \times 20 = 330{,}000$ foot pounds per minute, or 10 H. P.

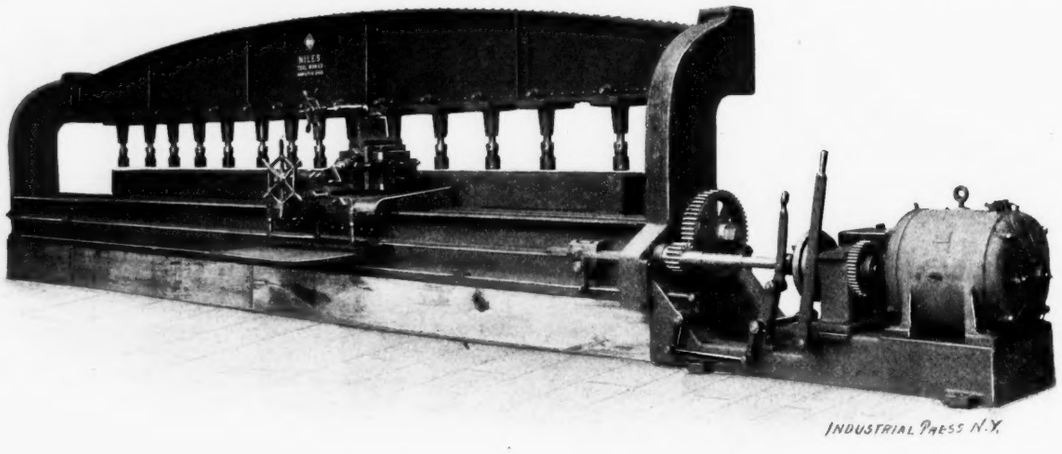


Fig. 1. Motor-driven Plate Planer.

Ever since planers were driven by electric motors, it was noticed that a great excess of power was required at the moment of reversing, especially from the cutting stroke to the return stroke. I do not doubt but that it was noticed before, only this phenomenon did not present itself in such an objectionable way as when a motor was used. The motor would spark and heat, and burn up brushes and commutator, and do all kinds of tricks calculated to make a man think,

or swear, according to his nature. At first it was not quite clearly understood why a motor should behave that way, and all kinds of remedies were proposed, most of which failed. Though this peculiarity of planers is fairly well understood by some people, I believe there are still a great many who do not quite catch on, and I will therefore try to explain what happens at the moment of reversal of a planer; the remedy will then suggest itself.

The way an ordinary belt-driven planer is reversed is as follows: The table is at the end of its cutting stroke; the dog touches the tappet, and shifts the tappet, which, in its turn, shifts a cam, operating the belt eyes. First one belt eye is moved while the other is stationary; then the second is moved, while the first is stationary. The moving of the first belt eye shifts the driving belt from the tight onto the loose pulley. If the shifting should stop at that moment, then the planer would be without motive power, because there is no belt on the driving pulley, and after a while the machine would come to a standstill, after running along for a little while by its own momentum. This running along by its own momentum is just exactly what the planer does when shifting, and after the driving belt is off the tight pulley. Of course the dog is still in contact with the tappet and, as the table is still moving, the tappet is being shifted further and this causes the cam to operate on the second belt eye, which now gradually brings the return belt on its tight pulley, which is still running, but in a direction opposite to that of the return belt. This belt, consequently, acts as a brake, and after a while brings the pulley to a standstill. This is the moment of reversal. The belt should now be completely on its tight pulley; for if it were not, it would never get there, as the dog has ceased to act on the tappet. As a rule, planers are so designed that the belt has a full seat on its tight pulley, just an instant before the planer comes to a stop. As soon as the planer has stopped, the belt begins to turn the pulley in its own direction, the pulley gathers speed, and by and by the planer is running at full speed on its return stroke. Of course the various operations are very much quicker than can be told; but the planer really goes through the different phases described here.

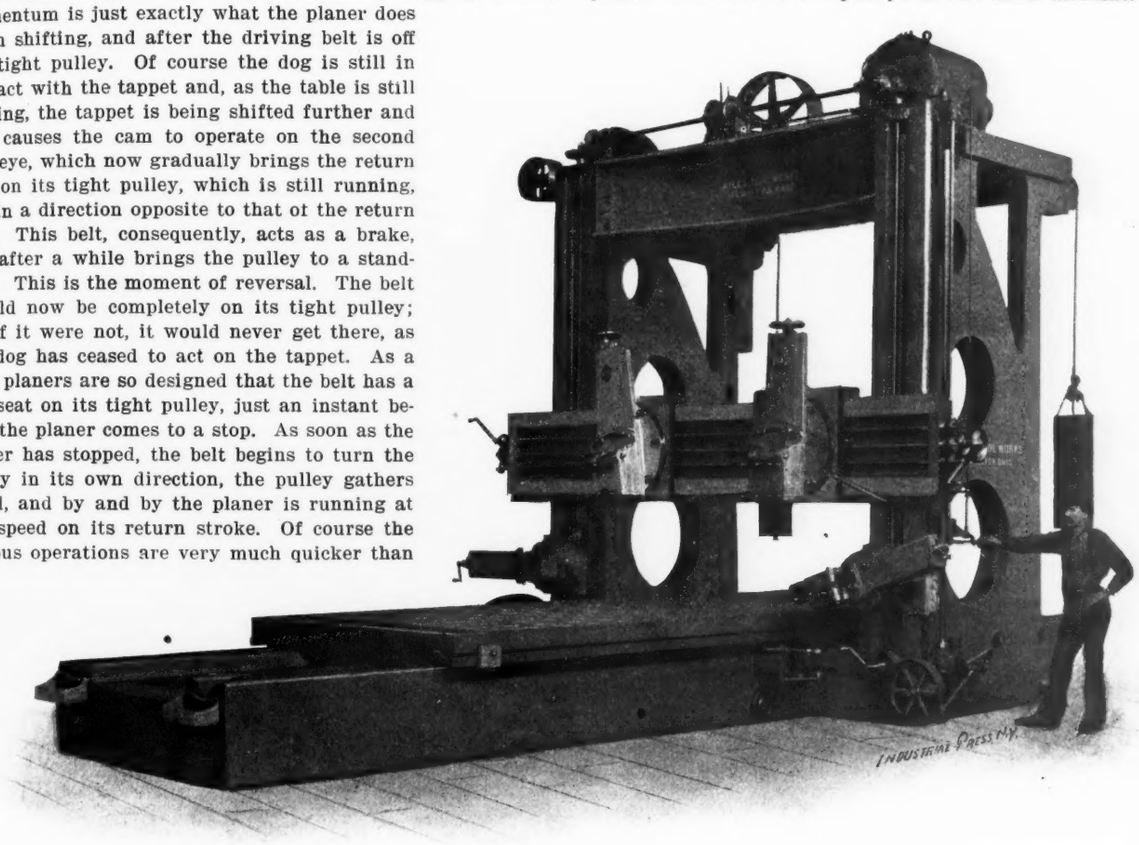


Fig. 2. Eight-foot Niles Planer Driven by Electric Motor located on top of Housing.

I spoke of the planer moving by its own momentum, when both belts are on the loose pulleys. Everybody knows that a planer does this. Most people, however, have the idea that it is the momentum of the table and the work which keeps the machine moving, as these are by far the heaviest moving parts. As a matter of fact, however, the momentum of table and work are extremely small, and capable only of moving a small fraction of an inch by their gathered-up energy. A simple calculation will show that the table of the planer mentioned above would move 5-24 of an inch on the cutting stroke, after the belt is thrown off, and 125-96 of an inch (or about 1¼ inch) on its return stroke.

The speed of the planer is 20 feet on the cutting stroke. It would have acquired this speed if it had dropped from a height $h = v^2 \div 2g$, in which v is the velocity in feet per second. In this case 20-60 = 1-3 and g is the acceleration of gravity in feet per second = 32. $h = 1\text{-}9 \div 64$. This is in feet or 1-48 in inches. This velocity enables the table to climb an inclined plane, of which the height again is 1-48 inch. The running of the table over flat ways, and against a friction of 10 per cent is equivalent to running up an incline with a grade of one in ten, so that it must run 10-48, or 5-24 inch before it stops. A similar calculation shows how much the table would run by its own momentum on its return stroke.

The question now arises, From where does the planer get the momentum which will drive table and work for perhaps several feet, and even sometimes chase it through a brick wall? Strange as it may seem, it gets this momentum from the driving pulleys, and, for a small portion, from the gearing. The momentum of a body, or its live energy, which is stored up in it, on account of its being in motion, is in proportion of its mass and the square of its speed. If, therefore, we multiply the weight of a body by the square of its speed, we obtain a number which is a measure for its energy; and which will enable us to compare this energy with that of some other body. Now let us compare the amount of energy possessed by the table and the work of our 12-foot planer with that of the pulleys of the same machine. The weight is 145,000 pounds; the speed is 20 feet; and therefore $145{,}000 \times 20^2 = 58{,}000{,}000$ is a measure for its energy. Now, assuming the pulleys to weigh 500 pounds, and to have a speed of 3,000 feet per minute, the energy of the pulleys may be similarly expressed by $500 \times 3{,}000^2 = 4{,}500{,}000{,}000$, which shows that the momentum of the pulleys alone is about 80 times greater than that of this extraordinary heavy table and work. Of course the momentum of other rotating parts, such as gears, etc., must be added to that of the pulleys.

Now let us see what happens, if we try to drive a planer by means of an electric motor. I know of a number of instances where the toolmaker calculated carefully how much power he had to supply to get a sufficient pressure against the tool, then added a certain percentage for loss by friction, and used a motor of the calculated capacity. This was all very simple, but the trouble came afterward. Let us make a similar calculation for our 12-foot planer, and see what the planer will do:

Pull on the table, 32,000 pounds; cutting speed, 20 feet per minute; power required $20 \times 32{,}000 = 640{,}000$ foot pounds per

minute, or about 19 H. P.; load (table and work) to be moved, 145,000 pounds; friction, 10 per cent; pull required for moving load, 14,500 pounds; power required for moving load, $14,500 \times 20 = 290,000$ foot pounds, or about 8½ H. P. In all, about 27½ H. P. Add 7½ H. P. for other frictional losses. Grand total, 35 H. P.

And so we order a 35 H. P. motor and drive the planer with it. We will place the motor somewhere on the top brace, and gear over to the countershaft, which we will support from the housing. In order to see what is going on we place an ammeter in the circuit. We start the motor without load, that is, with both belts on their loose pulleys; and then start the planer, but without any load whatever. As soon as we throw the belt on, the ammeter jumps up to a point which is equivalent to perhaps 50 or 60 H. P. It quickly goes down to perhaps 10 H. P. or thereabout. It remains at this point until the moment of reversal, when you may see it soar up to 120, 150, or perhaps even 300 amperes (equivalent to about 90 H. P.). I have seen the needle go up so far that the poor ammeter had to give it up, not being large enough for the occasion. This rush of current lasts only for a moment; the needle goes back to perhaps half the amount, and then gradually goes further back, to perhaps 15 H. P. (50 amperes).

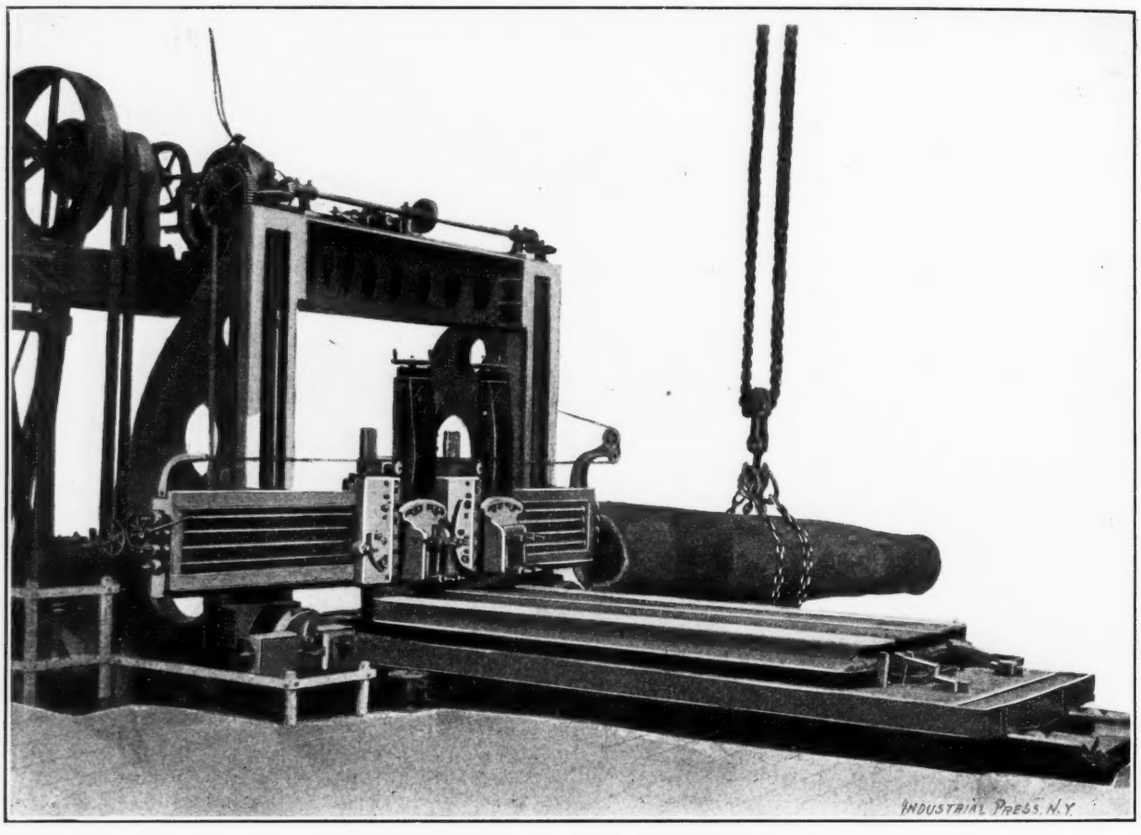


Fig. 3. Heavy Twelve-foot Planer, Electrically Driven.

By the way, I forgot to mention that we are using a 220-volt current. Now if you have followed the story of how a planer shifts, you will understand why the ammeter shows such excessive amount of current at the moment of starting or reversing. If you connect a shunt-wound motor to your line simply by means of a switch, without any starting box, you will find that at the moment you throw in the switch there is an excessive rush of current, resulting in violent sparking at the brushes and (if the motor does not start quickly) in the burning out of your armature. This might have been expected. The armature of a shunt-wound motor is wound with heavy wire, possessing but a very low resistance; so that an enormous amount of current will flow through it. In fact, so much will flow through this armature, that it is more than likely that your generating plant will not be able to furnish it all. The effect is almost the same as if you should deliberately short-circuit your generator. A motor is built exactly like a generator, and would act as such if it were driven by means of belt or, for that matter, by any other means. As soon as the armature rotates, it begins to generate current. If the motor is driven, not by a belt, but by the current from your line, the current generated by the motor will be in opposition to the line current; but this opposing current is always of a somewhat lower voltage than the current supplied from the line. If this were not so, there would not be any cause left why the motor should turn at all. Now then, as soon as the motor turns with a speed sufficiently high to create a fairly strong opposing voltage (counter-electromotive force), the current, which can flow through the armature is due to the difference of the supplied voltage and the opposing voltage, and, consequently, cannot be so very large. When the planer is started or reversed, a condition is created somewhat similar to that of trying to start the motor without a starting box. The countershaft pulley is running, driven by the motor; but the lower pulley is standing still and, as long as this lower pulley is not quite up to its speed the motor must slow down, or the belt must slip. As a matter of fact, both will happen.

Of course all this is equally true when a motor has to start any other tool under load; but the difference is that any other tool is started once or twice or, at the worst, a few times a day, while a planer has to be started under load every minute, and often every few seconds. The reversing of a planer is a good deal worse than the starting; for the motor must not only give enough power to the planer to get up speed, but also power to overcome the energy possessed by the parts then moving in opposite direction. A shunt-wound motor tends to run at a certain fixed speed, and any condition which compels the motor to run at a lower speed greatly increases the current flowing through the armature, and this, of course, is detrimental to the delicate parts of the commutator, etc. An example will easily show how slight changes in speed greatly increase the current taken by a motor.

Suppose we have a shunt-wound motor, working on a 220-volt circuit and taking 50 amperes at full load, and suppose the speed to be 645 R. P. M., and that the resistance of the armature is 1-10 ohm. As 50 amperes must be forced through a resistance of 1-10 ohm, 5 volts will be required to do this, and 215 volts are left which will have to be neutralized by

the counter electromotive force generated by the motor. The condition of armature and field, therefore, must be such that if the motor were worked as a generator it would generate 215 volts, when run at a speed of 645 R. P. M. Though, of course, it is not true that 3 R. P. M. would generate 1 volt, it is true enough for our purpose, to say that 3 R. P. M. are required *per volt* generated. Now suppose the motor shaft is held by some friction device, which prevents it from running at more than 600 R. P. M. It will then generate only 200 volts; and there are 20 volts left, which, of course, will force 200 amperes through the resistance of the armature. So that a drop of 45 R. P. M. raises the current from 50 to 200 amperes.

The proper way to overcome the difficulty would be to make the belt between countershaft and machine very elastic, so as to allow the countershaft to go on at full speed, or nearly so, even when for a moment the driving shaft is standing absolutely still. How unpractical this would be, however, does not need to be told. When a planer is running in an engine-driven shop, this elastic medium is always provided, thus relieving the engine of the terrible strains which the reversing of a big planer would impose on it. For there is a belt between engine shaft and jack shaft, and one between jack shaft and line shaft, and one between line shaft and countershaft, and one between countershaft and machine shaft; and then there is the elasticity of all the shafts to be taken into account. Very little of this is left in the motor-driven planer. Some happy (?) possessors of early motor-driven planers have tried different means of doing away with the trouble. One of the expedients was putting a flywheel on the countershaft, so as to help it over the critical period. Of course this did not help; it generally made matters worse. What was needed was not a device to keep the countershaft running, but something to bring the shaft to a standstill, without putting too great a duty on the motor. If it could be arranged to stop the motor gradually and synchronous with the driving pulleys, and then start it again with an ordinary starting box, the thing would be done. Another cure for the above-described trouble was to use a compound-wound motor. This class of motor will give a very heavy starting torque, if heavily compounded, and would allow a considerable drop in speed without an excessive rush of current. The drawback, however, is the uneven speed under varying load, and especially the excessive speed with which the tool would run up against the work. A great many shop owners who had trouble with their planers in the early days of the electric drive substituted a compound-wound motor for their shunt-wound motor, and overlooked the faulty speed regulation in their happiness over stopping the sparking and burning out of their armatures. I know of one manufacturer who, in desperation, put a flywheel on his countershaft and a compound-wound motor of a great deal larger size in place of his shunt-wound motor, and so overcame the difficulty to a large extent. He did not seem to know, however, that his flywheel was a detriment instead of a blessing. Toolmakers have come to recognize, at the present day, that perhaps the simplest way out of the trouble is to use a motor of such a size that it is not only large enough to drive the planer, but also able to stand the strain at the moment of reversing without bad results. This is, after all, as cheap and simple a method as any. One can find many an electrically-driven planer which takes only say, 10 H. P., when taking the heaviest cuts the planer will stand, and which is driven by a 20 H. P. motor. Another cheap and effective cure is to interpose as much belt length as possible between the motor and the driving pulley.

Fig. 1 shows an electrically-driven plate planer. A plate planer does not offer quite so many difficulties as an ordinary planer, as it has no quick reverse, both strokes being used for cutting. Besides there are no heavy loads to move, the work being stationary; and the carriage which carries the tools, and is moved along the work, is relatively light. The electric drive shown here overcomes the difficulties due to the momentum of the pulleys by not using any pulleys at all. The machine was driven by a reversible motor, geared to a shaft upon which was a friction clutch. This friction clutch is not essential to the drive, but was put there because it was so specified by the purchaser. The intermediate shaft was in its turn geared to the screw which moves the carriage. The reversing of the stroke was accomplished by reversing the motor. For this purpose a Cutler hammer controller of the automatic reversible type was used. The word "automatic" does not mean here, as with ordinary controllers, that the starting lever is held in the "on" position by a retaining magnet, but that the operator is not able to throw the current on any faster than the controller will let him. In other words, the operator might give the starting lever a sudden jerk from "off" to "on," and still the controller would act as if the operator had slowly and deliberately moved the lever from step to step. Such controllers are largely used with electrically-driven elevators. The elevator boy very rarely is a high-grade mechanic or a skilled electrician; and means must therefore be provided to prevent him from wrecking the motor and jolting his passengers too severely. The controller used with the planer mentioned above had a shaft extending through it, which was given a partial turn by some shafts, levers and connections, all plainly shown in Fig. 1. These shafts were operated by a lug on the carriage striking a collar on the shifter rod. The partial turn of the above-mentioned shaft would turn a heart-shaped cam which, in the "off" position, supports a contact arm that may slide over contact segments of the controller. As soon as the cam drops, this arm also drops, but is prevented from doing this too quickly by a dashpot filled with oil, or, perhaps better, with a mixture of glycerine and alcohol. The reverse motion of the cam lifts the arm, and, as the dashpot now offers no resistance, this movement can be accomplished as quickly as the operator may desire. As the dropping motion of the cam causes the motor to start, and the lifting motion causes it to stop, it will be seen that the starting is always done gradually, but that one can turn off the current as quickly as one may desire.

As the carriage moved along, a lug would strike a collar on the shifter rod, and give this rod an endwise motion. The distance the carriage will keep on moving before the motor is reversed is an unknown quantity, or, at least, was so before the machine was actually running, and for this reason the shifter rod was not allowed to work directly on the system of levers and connections mentioned above, but was provided with a set of dogs, acting on a tappet on the first lever, much like the ordinary planer shifting arrangement. In this way provision was made for the carriage to run over, after the controller was reversed, and before the motor had started in the opposite direction. The first time such a controller was made for this purpose, it was thought necessary to make some provision for taking up the momentum of the armature at the time the motor was reversing. The device for this purpose consisted in a certain amount of resistance, which was automatically switched across the armature of the motor, after the current had been turned off, and before the current had been turned on again in the opposite direction. The motor, driven by the momentum of its armature, would act for a short time as a generator, and the current thus generated would be dissipated in the resistance. It was found later on, however, that this device was not necessary, as the motor would reverse as quickly as one could operate the controller, and this without bad results to either motor or controller.

Fig. 2 shows an 8-foot planer driven by a motor. The countershaft is supported on brackets on the side of one housing, and the motor is placed on top of the machine and drives the countershaft by a belt. The motor was of ample size; this and the long belts overcame the difficulties mentioned before.

Fig. 3 shows a very heavy 12-foot planer. A peculiar feature of this planer is that it is driven by three belts—one belt for the return and two for the cutting stroke. The power required was so great that a 12-inch belt would have been needed, and of course this would have been too wide to have been readily shifted. It was therefore split into two 6-inch belts, each of which was operated by its own belt eye. The motor was geared to the countershaft, as can be plainly seen; and the size of the motor had to be far in excess of what was required for actually doing the work, in order to keep it from being wrecked.

A relatively new departure in planer drivings is the magnetic clutch; but of this, more later on.

UNIVERSAL OR FLEXIBLE JOINT COUPLINGS.

PRINCIPLES, CONSTRUCTION AND LIMITATIONS.

Shaft couplings having the feature of transmitting rotary motion through an angle which may be varied to accommodate the moving elements of a mechanism are commonly known as universal joints, flexible couplings, universal joint couplings, gimbal joints and, more rarely, Cardan's couplings and Hooke's joints. Cardan (1501-1576) is said to be the first person to describe a universal joint coupling and Hooke (1635-1702) was an Englishman who is credited as being the first one to actually apply it to the transmission of rotary motion. It seems quite improbable that this is true since the principle had been known fully one hundred years before, but whatever the history of the universal joint may be, it is of little consequence to the practical mechanic as compared to a knowledge of the principles, construction of various forms, applications, and limitations of this exceedingly useful, but often misused mechanical member.

Principles.

Fig. 1 shows a common and typical form of flexible joint, in duplicate, which will be employed to illustrate the principle of operation. The cut shows two joints properly joined for transmitting uniform rotary motion. Motion may be considered as being transmitted from the shaft at the left to the one at the right and through an included angle of angle x

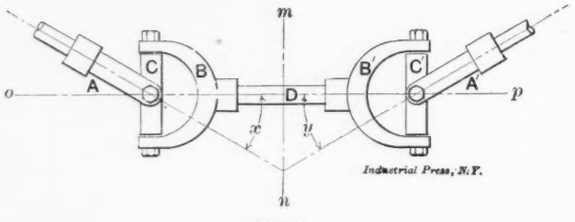


Fig. 1.

plus angle y. Jaw A, block C and jaw B, together with the pins or screws flexibly connecting the jaws to the block, form one joint, and jaw B', block C' and jaw A' form the other joint. The angle x is the angle made by the projected axis of the shaft at the left with the axis of the intermediate shaft D, and angle y is the angle made by shaft D with the shaft at the right. These angles must be equal, and jaws B and B' must be parallel and in the same plane in order to transmit motion at the same angular velocity at all points of one rotation. In addition the cross axes of jaws A and A' must lie in the plane of the shafts when both are turned 90 degrees from the position shown, and the cross axes of each pair of jaws making a joint must intersect at the intersection of the center lines of the connected shafts. If the cross axes of each pair of jaws do not intersect, but instead they are connected by

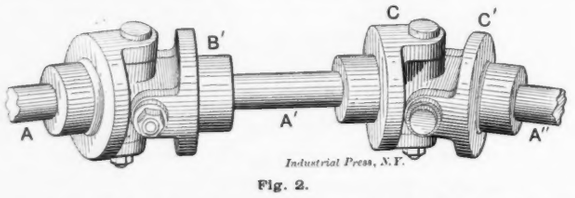


Fig. 2.

through bolts, like the joint shown in Fig 9, there will be a slight endways movement twice during each rotation. This may not be objectionable in some classes of machinery, especially if the angle made by the connected shafts is small, as the endways movement is slight. Consequently this form of universal joint has been largely employed in agricultural machinery, chiefly for the tumbling rods connecting horse powers with grain threshers. The through-bolt joint is a construction that is easily connected and disconnected, and is also cheap to manufacture.

When two shafts are connected by one flexible joint of the type shown in Fig. 1, there are four points in one rotation at which the angular velocity of the driving and intermediate shafts are equal. Between these points the angular velocity alternately increases and decreases in the proportion: $a_1 : a :: \cos x : 1 - \sin^2 a \sin^2 x$, in which a_1 is the angular velocity of, say the driving shaft, a the angular velocity of the driven shaft, $\cos x$ the cosine of the angle of the connected shafts and $1 - \sin^2 a \sin^2 x$ is 1 minus the square of the sine of any angle of rotation (at which a comparison is to be made with a corresponding angular position of the driven shaft) multiplied by the square of the sine of the angle of the shafts. The following table from Reuleaux's Constructor shows the angular variation at various points in one-half rotation, for shaft angles of 10, 20, 30 and 40 degrees.

a	$x = 10°$	20°	30°	40°
0°	0°	0°	0°	0°
30°	29° 28′	28° 29′	26° 34′	23° 51′
45°	44° 34′	43° 12′	40° 54′	37° 27′
60°	59° 34′	58° 26′	56° 22′	53° 04′
90°	90°	90°	90°	90°
120°	120° 26′	121° 34′	123° 38′	126° 56′
135°	135° 26′	136° 48′	139° 06′	142° 33′
150°	150° 22′	151° 31′	153° 26′	156° 01′
180°	180°	180°	180	180°

In the table the values of the angular positions a begin with $a = 0$, which corresponds to the position occupied when the cross axes or cross journals of a coupling lie in the plane of the shafts. In Fig. 1 the cross axes of the jaw B (also B') lie in the plane of the shaft. At this point and at 90 degrees removed the angular velocity of the driving and driven shafts of one joint are equal; between these points the velocity varies in the proportion given. The least speed of the driven shaft will be the rate of the driving shaft multiplied by $\cos x$, and

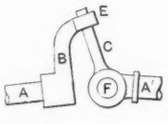


Fig. 3.

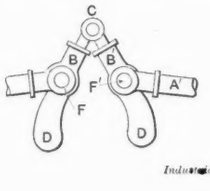


Fig. 4.

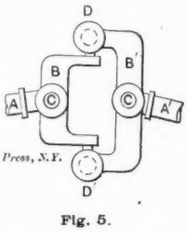


Fig. 5.

the greatest speed will be the rate of the driving shaft multiplied by $\frac{1}{\cos x}$. That is, the rate of angular rotation will vary in these ratios. Suppose the angle x is 30 degrees, and the rate of the driving shaft is 100 turns per minute: The slowest speed of the driven shaft will be at the rate of $100 \times .866$ ($\cos x$) $= 86.6$ turns per minute, and the greatest rate will be $100 \times \frac{1}{\cos x} = 115.4$ turns per minute.

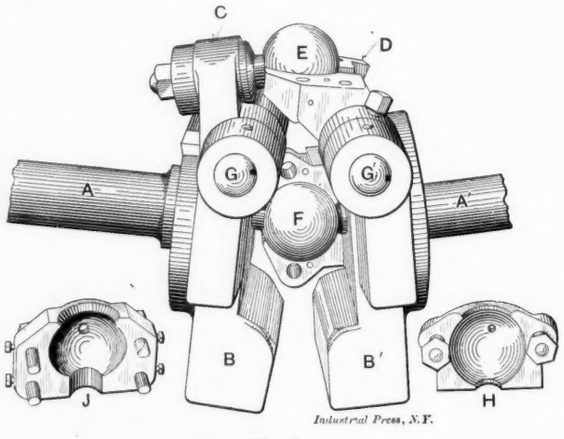


Fig. 6.

Now since the intermediate shaft would be driven at this irregular rate (supposing the driving shaft were driven at a regular rate), whether it was driven by either the shafts at the left or right, it of course follows that it must transmit regular motion from either right or left shaft if angle x equals angle y. If, however, the cross axes of a pair of universal

joints are placed, as shown in Fig. 2, the irregularity of transmission caused by one joint is greatly increased. Instead of the least and greatest rates being in the proportion of cos x : $\frac{1}{\cos x}$, they are in the proportion of $\cos^2 x : \frac{1}{\cos^2 x}$. Hence the rate of shaft driven through such a combination by a shaft turning 100 times per minute, would vary from 75 to 133 1-3 turns per minute, a variation that could scarcely be tolerated for any purpose.

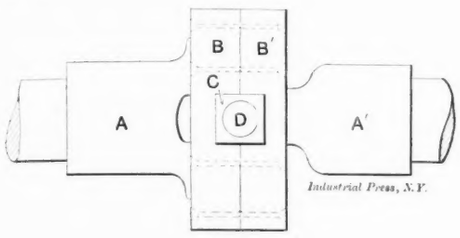


Fig. 7.

There is a form of universal joint coupling which transmits uniform rotary motion to shafts in angular position without requiring a duplicate joint and an intermediate shaft. Reuleaux describes it by first giving Fig. 3, which is a disguised form of flexible joint, in which C takes the place of the block, and the hinge joint F the place of the pins in one pair of jaws. C being cylindrical, it is free to turn in the end of the arm B, and also slides lengthways in it. In this form of joint the irregularity of motion is exaggerated over that of the

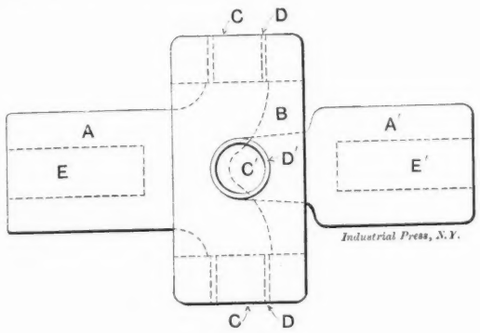


Fig. 8.

ordinary form. But if a duplicate of C and joint F be substituded for B and a suitable yoke provided to connect ends $C\,C$ so that they will be free to turn in it, the combination will transmit uniform motion. A still better form embodying the same principle is outlined in Fig. 4, in which the arms $B\,B'$ are jointed at $F\,F'$ and counterweighted at $D\,D$. Fig. 5 is on essentially the same principle, the shafts $A\,A'$ being jointed at $C\,C$ to the jaws $B\,B'$. The jaws are connected by ball joints at $D\,D'$. This coupling was patented in the United States in 1869 by Clemens. It has been used for angles as great as 90 degrees.

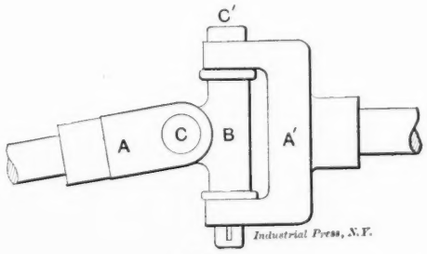


Fig. 9.

The universal joint used in the mangle gear shaft of the Babcock printing press operates on the same principle. One form of this joint is shown in Fig. 6, in which the working parts are counterweighted by the weight arms $B\,B'$. Another form used on larger presses made by the same firm has duplicate parts on the opposite side of the shaft in place of the counterweights. One set, as shown in Fig. 6, fulfills the function of a perfect universal joint, but the duplicate members in the larger joint are employed for greater driving strength. In this joint A is, say the driving shaft and A' the driven shaft, both of which are keyed into the driving arms. These arms bear at the upper ends the jointed connections C and D, which turn on the pivots G and G'. The connection between C and D is a ball joint E, the cap of which is shown at J. To prevent endways movement another ball is mounted on

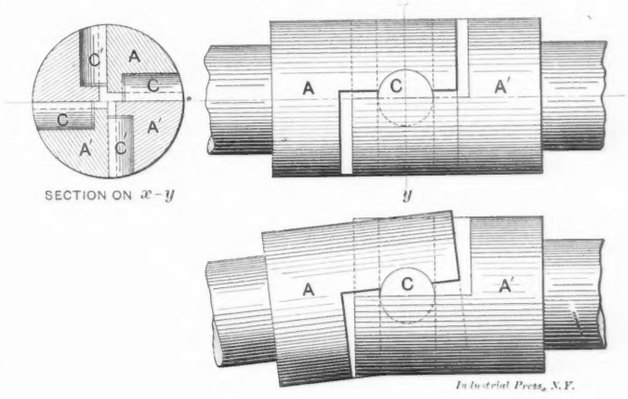


Fig. 10.

the axis of the shaft A and held in a ball case mounted on the axis of shaft A'. The cover to this ball joint is at H.

The Clemens joint transmits uniform rotary motion when the shafts are inclined to one another, as shown in Fig. 5, or when they are parallel and in the same axis, but if they are parallel and not in the same axis, being offset, the motion transmitted will be very irregular. Thus if the angle made

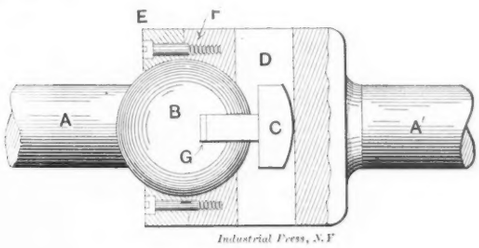
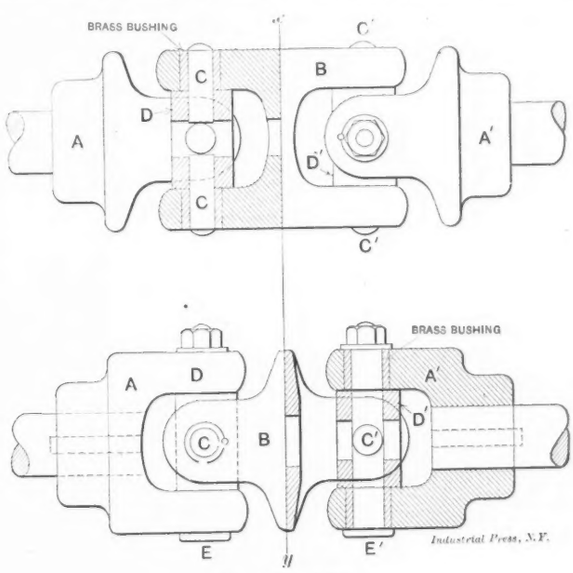


Fig. 11.

by the shafts with the plane intersecting the ball joints be 30 degrees, the motion will vary from ½ to 2 times the rate of the driving shaft.

Construction.

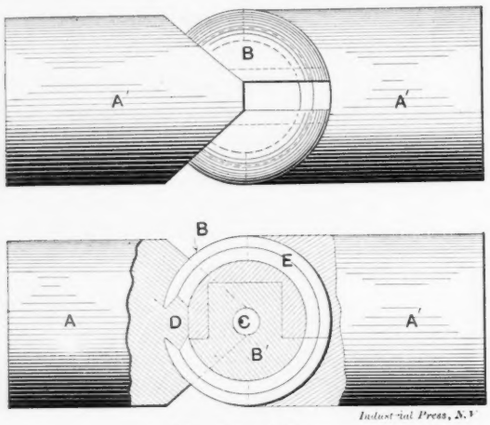
We will now revert to the more ordinary form of flexible shaft coupling and describe some of the styles in which it has appeared. Fig. 7 has been used where great strength is required, as for propeller shafts. What corresponds to the block in Fig. 1 is a double ring $B\,B'$ held together by rivets



Figs. 12 and 13.

and encircling the jaws. The jaws *A A'* have pins forged on their ends, as at *D*, over which are fitted square bronze boxes *C*. These boxes are securely held between the rings *B B'*, which must be separated in order to dismount the joint.

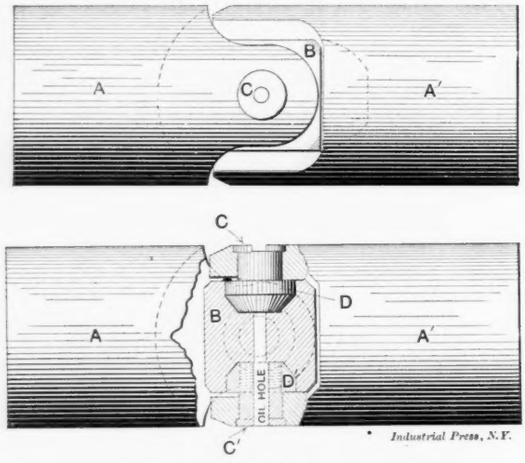
Fig. 8 is a joint that has been used on the tumbling-shafts of agricultural horse powers. It is made entirely of cast iron, with possibly the exception of the bushings *D D*, etc., surrounding the pins *C C*, etc. The shanks *A A'* have square holes cored at *E E'* for the ends of the shafts or rods, which are of course squared to correspond. The ring *B* is cast around the parts when set up in the mold. The bushings prevent the hot iron seizing the pins, and so make a free working



Figs. 14 and 15.

fit possible with cast construction. The coupling cannot be dismounted without breaking the cast-iron ring holding the parts in position. Of course this construction is only adapted to rough, cheap work. Fig. 9 has already been referred to as being used for the same class of work.

In Fig. 10 we have a universal joint made for extremely heavy and trying work. It was designed by Julian Kennedy, of Pittsburg, for steel rolling mills. It consists of two pairs of clutch jaws, each of which subtend somewhat less than 90 degrees at the center and which are engaged, as shown. One face of each jaw is cut out to fit the half-cylindrical pins *C C* and *C' C'*. These pins are free to turn through a limited angu-



Figs. 16 and 17.

lar distance in the jaws and are also free to slide on the faces of the opposing jaws. This construction satisfies the requirements of a universal flexible joint of limited angular capacity and makes a construction of great strength, as all the smaller and weaker parts are in a state of compression when transmitting motion. This joint is a modification of an old form of universal joint in which half-spheres were employed in the same manner instead of half-cylinders. It cannot, of course, be used where the angular difference is great and it is also necessary to have the shafts held against longitudinal movement by collars as the joint itself does not prevent endways movement.

Fig. 11 is a neat form of joint which, however, is a striking contrast in the matter of strength to the one preceding. It is only adapted where the work is very easy as the parts are not proportioned or arranged to advantageously resist torsional stress. The shaft *A* has the ball end *B* integral with it. This ball has a slot cut across its end at *G* for the part *C*. Part *C* slides in *G* and in the vertical groove *D* which fits it closely on the sides. The cap *E* retains the ball in its socket.

Figs. 12 and 13 show two views, both partly sectional, of the flexible joint made by the Dodge Mfg. Co. This coupling is made with two complete joints connected by the intermediate part *B*. One through-bolt is used in each joint, yet the cross axes intersect, short pins, *C C* being used for the mating jaws. Both the pins and bolts work in bushings which are doweled to prevent turning in the jaws. The blocks *D D'* are square

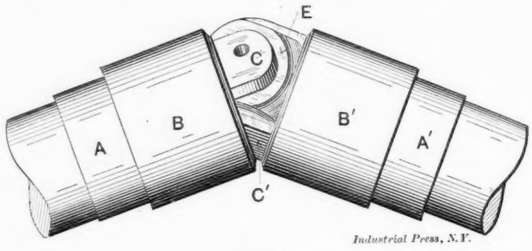


Fig. 18.

and are fitted closely to the jaws which thus act somewhat the same as socket wrenches on the block, thus relieving the pins of part of the torsional stress.

Figs. 14 and 15 show exterior and sectional views of a universal joint made by the Vanderbeek Tool Works, Hartford, Conn. It has been extensively used in machine tool construction and is well known. A ball *B* connects the mating shafts *A* and *A'*. This ball has two undercut grooves in its periphery at right angles to each other. The ends of the shaft engage in these grooves as indicated in the sectional cut. The shape of the grooves is also indicated in the sectional cut by *E* and the cross section *D*. The ball is made in two parts marked *B B'* and in male and female form. A pin *C* through both parts holds them together. When the joint is to be taken apart *A* and *A'* are bent together as far as possible and the pin is knocked out. In this position the shaft can then be disengaged.

The Vanderbeek joint is neat and attractive in appearance and remarkably strong when it is considered that its largest

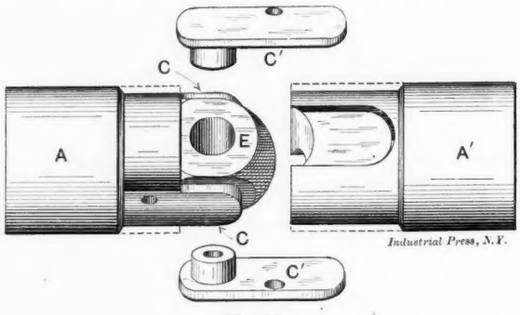


Fig. 19.

diameter is the same as that of the parts *A* and *A'*, and that the bearing surface is necessarily all near the center. It is customary when using these joints in machine construction to bore out parts *A A'* and to connect to them shafts of the same diameter, the shafts, of course, being turned down to fit the bored hole. Thus a 1½ inch joint is joined to a 1½ shaft but it cannot consistently be required to transmit the power that could be safely transmitted by a solid 1½ inch shaft, for obvious reasons.

Figs. 16 and 17 show an improved form of universal joint made by the Vanderbeek Tool Works, which is considerably stronger for the same diameter than the one just described. In this joint we have a typical universal joint of four jaws. These jaws are connected to a square block *B* of hardened steel. The jaws fit closely on the sides of this block and thus relieve the parts *D D'* and screws *C C'* of part of the torsional

stress, acting like socket wrenches as already mentioned of Figs. 12 and 13. The jaws are made very short and stiff, yet ample room is afforded for the greatest permissible angular movement. Space is afforded for the movement of the block and opposing jaws by scooping out a concave space between each pair of the jaws, as indicated by the dotted lines. The block is recessed on four sides for hardened steel pieces, two of which are shown at *D D'*. These pieces are tapered at their inner ends and fit in seats of corresponding shape. Screws *C C'*, etc., draw these parts solidly against their respective jaws. Projections on their outer faces fit into grooves on the inside faces of the jaws, for preventing their turning and

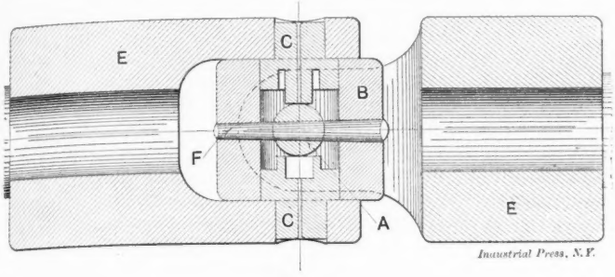


Fig. 20.

loosening the screws. The shape of the pieces *D D'* is thought advantageous in resisting torsional stress as the resultant of such stress is believed by Mr. Vanderbeek to affect the jaws less than if of almost any other shape.

This joint was tested by Prof. E. F. Miller of Massachusetts Institute of Technology with the following result: A 2-inch joint was subjected to a series of torsion tests, the stress being increased 150 pounds at each time. With a pressure of 740 pounds at a radius of one foot some distortion of the joint was perceptible and with 950 pounds pressure at the same radius the joint failed. So the maximum power that such a joint could transmit at 100 turns per minute would be,

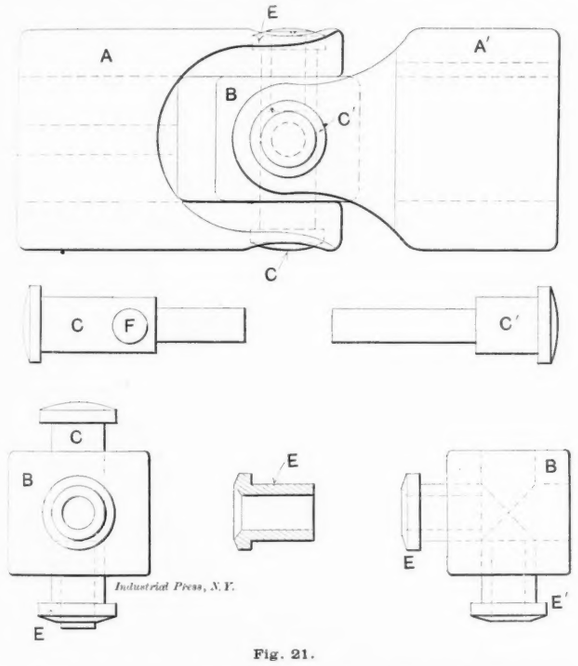


Fig. 21.

say, about 14 H. P. An oil hole is drilled through the screws and block as shown, so that the joint may be oiled in any position in which it may happen to stop.

Figs. 18 and 19 show exterior and constructional views of a universal joint made by Gray & Prior, Hartford, Conn. In Fig. 18 *B* and *B'* are steel rings shrunk on *A* and *A'* for holding the jaws *C C* and *C' C'* in place. These jaws are drop-forged, with projections on the inner surface of the outer ends, for engaging the holes in the block *E*. Fig. 19 shows the construction clearly. No screws or pins are used in the block, the bearing parts being integral with the jaws. When the joint is assembled it cannot come apart unless the rings *B* and *B'* work loose. A piece of felt is packed in the block at the intersection of the holes and an oil hole is provided in one of the holes *C'*. The oil in the felt pad is thrown outward by centrifugal force when the joint is in motion and keeps the joint constantly lubricated. The jaws are doweled through *A* and *A'* to prevent their being pulled endways when subjected to longitudinal stress. It may be remarked parenthetically, however, that a universal joint should not be subjected to longitudinal stress if it is expected to wear well.

Figs. 20, 21 and 22 are three forms of the Bocorselski joint made by the Baush Machine Tool Co., Springfield, Mass. Fig. 20 is of quite novel construction. A taper pin *F* holds the parts in the proper relative position. It passes through pin *A*, which forms the cross axes bearing of the two jaws at the right. When pin *F* is removed *A* can be removed and then *C* and *C'* can be forced into the block far enough so that the outer ends will clear the jaw and permit the removal of the block *B*. In Fig. 21 the pin *C* is drilled at *F* for the cross pin *C'*. The small ends of these pins are provided with bushings, *E E'*, which turn in the jaws of *A* and *A'*. The ends of the pins *C* and *C'* are headed over to prevent their working out. The details of construction are clearly shown, so that further explanation is unnecessary. In Fig. 22 the construction is

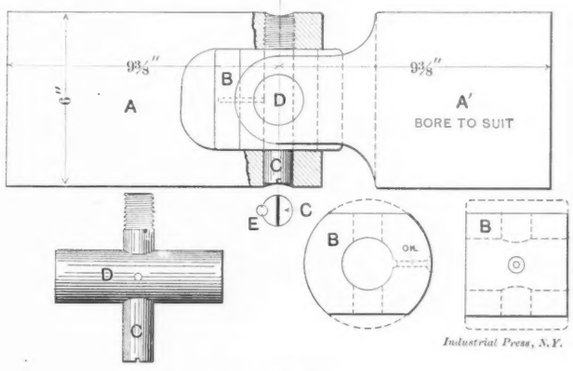


Fig. 22.

varied by making *D* relatively large so that the pin *C* passing through it at right angles shall have ample strength to resist shearing stress. It is threaded at one end and slotted for a screw driver at the other. Pin *C* works in the block and pin *D* works in the jaws. A dowel hole *E* is drilled one-half in the pin and one-half in the jaw to hold it from working out. An oil hole is provided in the block, for lubrication. The dimensions on the cut give an idea of the size in which these joints are made.

The joint shown in Fig. 22 has been severely tested. A two-inch joint has driven a two-inch twist drill at the rate of 75 turns per minute and with a feed of one inch per minute cutting tool steel. The shank of the drill eventually twisted off without the joint showing distress. The joint during the test was running at an angle of 35 degrees. They are not recommended, however, to be run at a greater angle than 15 degrees, as the wear and friction are proportionally increased with the angle, a condition that affects all types of universal joints and that should always be remembered in machine design.

* * *

In our March issue we referred to the new self-hardening steel lately introduced in England by Wm. Jessop & Sons. We have received from an English subscriber, Mr. Wm. Wright Nicholas, further particulars regarding this remarkable steel and the advantages to be gained from its use. "The steel," he writes, "can be hardened by any blacksmith, as the process is quite simple; but the special feature about it is the speed at which it will work without the edge becoming dulled, even when dealing with very heavy cuts. It is regularly working at speeds varying from 20 feet to 45 feet per minute on diameters from 15 inches to 26 inches and with cuts up to 1 inch by ⅜ inch.

"In one instance it has cut 450 pounds off a certain shaft (whose tensile stress was about 30 tons per square inch and diameter about 14 inches) in the short period of two hours without being reground once."

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1902.

THE METRIC SYSTEM AGAIN.

Since going to press with the March number of MACHINERY, a report has been issued by a committee of the American Society of Mechanical Engineers with regard to the pending metric system bill. The report is adverse to the passage of the bill and urges all members of the society to use their influence against its passage. The wording of the report, however, is such as to give the impression that if the metric system bill were passed the English system would become illegal in contracts, and to avoid a misunderstanding of the scope of the bill the House Committee having it under consideration have asked for an opinion from the attorney general with regard to this point. He states that the purpose is to establish the metric system as the legal standard in the United States and to require all government departments to use only that system. While it prohibits to the departments the use of any other system, it cannot be construed as attempting to compel the people to use only that system or as making contracts expressed in other terms invalid.

It is noticeable that the advocates of the metric system are showing more enthusiasm and have an audience with the committee more frequently than those who are upholding the English system. Some of the evidence submitted, moreover, is of such a character that it is quite likely to be misleading, as it does not touch the essential point with machine manufacturers at all. Thus, letters of inquiry were sent to different manufacturers by Director Stratton of the National Bureau of Standards, asking whether tools could be supplied in the metric system for use in the machine shop of the bureau at Washington. The replies to these were submitted to the committee, and naturally, they were in the affirmative, because all that the inquiry implied was the ability of the machines to *turn out work*, such as screw threads, etc., having metric dimensions. This, of course, is regularly done by nearly all builders, and is a very simple matter; but the machines themselves are built according to the English system, with the inch and its subdivisions as the standard of measurement. There is no reason to suppose that any manufacturer of machinery in this country would desire to use the metric system in the manufacture of the component parts of his machines. As stated in the last number, it is apparent that there is an undercurrent of thought favorable to the metric system at the present time. It is unquestionably the best system for scientific work, but the English system is so much more convenient for shop operations that we believe no radical change in shop measurements can take place outside of the government works for many years to come.

* * *

THE RUSSIAN MARKET.

The importance of the Russian market for iron and steel as well as for machinery has attracted attention for several years; and particularly during the past year in view of the tariff of 30 per cent. levied by the Russian government upon imports of iron and steel products from the United States, in retaliation of similar duties imposed by the United States upon Russian sugar.

The importance of the Russian market is best illustrated by the fact that during the year 1900 the imports of machinery amounted in value to more than $52,000,000, as compared with about $74,000,000, the value of the machinery production in Russia during a corresponding period. There is a strong movement in Russia at the present time toward proving their facilities for supplying the home market, especially in the machine tool line, and at the second Congress of the Iron and Steel Manufacturers of Southern Russia, recently convened at Kharkoff, much time was given to the study of the present situation of the mechanical industry in Russia and in devising means for its improvement.

There has been a falling off in the construction of new engineering works since 1900 and Russia is handicapped by the lack of skilled labor. It will take many years before the market can be supplied by products manufactured in that country and it is to be hoped that tariff conditions will be so changed as to permit the importation of more American tools in the near future. This is all the more the case from the fact that German and British tools find a ready market there and often are preferred to American tools. With regard to this the British Consul General at Moscow, Russia, says:

"The market is in favor of British machine tools, especially the Scotch, but some German makers hold their own in competition with the British article. The general run of German tools, as also of the American (which are admirable in construction) are regarded by the Russian workmen as a trifle too flimsy. A judicious combination of the British and American makes, which some British firms are now sending over to Russia, seems to be quite the right article for this market."

At the Kharkoff congress a prominent Russian engineer presented a report, in which it was pointed out that the opportunities for cultivating a market for gas and oil engines in Russia were very unusual, as indicated by the fact that the imports of these have increased two and one-half times during the past five years. Here is another opportunity for American manufacturers in a field which Russia is now making strenuous efforts to supply with her own products.

* * *

COLLEGES.

It is far better for the technical schools not to attempt to teach practice. Let them rather concentrate their efforts upon theory, as they have not the facilities to teach practice, and as it is changed before it is taught. There is more than enough theory to occupy their time, and the majority will never learn it if not taught at the schools. They cannot get too much. At the end of the course, upon passing satisfactory examinations, give the graduate a scientific degree. For they are not engineers, and no school can ever make them such. When they have had at least five years' experience with practical work, and upon writing a satisfactory dissertation on some theoretical or practical engineering subject, then let them receive their engineering degrees.—Alex. Rice McKim in *Engineering News*.

Quite right. Engineering schools cannot teach practice, and the degree of "engineer" loses its significance by being bestowed upon young graduates who are not in any sense engineers. Give the boys their fill of theory, for they will not have time for it afterward; but if with this they could be impressed with the fact that practice can be learned only in actual commercial work, and that they will not become engineers until they have acquired such experience, a great step in advance would be gained in technical education.

We believe in laboratories, drawing rooms and workshops in connection with college courses, when rightly conducted; but sometimes they may do a student positive harm instead of advancing his interests. Students somehow get the impression that these adjuncts teach practice; that they make practical men of them and supplement their class room exercises to such an extent that after graduation they are in a position to accomplish almost any mechanical or engineering work. This idea, we are sorry to say, is too often encouraged by college professors, some of whom are prone to teach that one may acquire all that is really worth while at college.

The function of the laboratory should be to imbue the stu-

dent with a spirit of investigation. The function of the drawing room and shop at school should be to impress him with the importance of practical work. They will also show him something about methods, and the more the better, but instructors should be careful to teach that the full knowledge of these methods can come only by working side by side with men who have to earn their living and in shops where time and cost are the most important factors—conditions that do not exist at college.

* * *

NOTES AND COMMENT.

The seventh annual convention of the National Association of Manufacturers will be held in Indianapolis April 15, 16 and 17. Members of the association are manifesting rather more than usual interest in this year's convention, and there is promise of an unusually large attendance from all parts of the country. The National Association of Manufacturers was organized in Cincinnati in 1895.

One of the latest determinations of the sun's temperature has been made by Prof. Chas. Wilson in England, who estimates it to be 11,192 deg. Fahr.; and the absorption of the sun's atmosphere makes this temperature equivalent to 11,880 degrees at the surface of the sun. The intensity of heat at these temperatures can best be imagined by comparing with the temperatures of molten bodies with which we are acquainted. The white heat of the metal in an open hearth steel furnace seldom exceeds 3,000 degrees, and is usually less; blast furnaces attain a temperature of 3,500 degrees. All of the precious metals melt at considerably lower temperatures, with the exception of palladium, which melts at 2,700 degrees and platinum, which melts at 3,200 degrees. Platinum withstands high temperatures so successfully that it is used by chemists for crucibles in which the more refractory substances are reduced in the process of analysis; but it would not only melt at the sun's temperature, but would probably be converted to a gas.

A Washington dispatch in the *New York Herald* contains particulars about experiments in wireless telephony that have recently been conducted in the vicinity of Washington. The messages were received on a small steamer stationed on the Potomac and were sent from a land station half a mile distant. Complete sentences and strains of music were distinctly heard, and later land tests were made that were even more satisfactory. The experiments, however, do not seem to involve any new principle. In the days before the metallic circuits for telephone lines it was not uncommon for messages to be transmitted from one parallel line to another, and two or three years ago messages were sent out from the Nantucket Lightship and were heard at a considerable distance. The principle in each of these cases, as in the later experiments, is the same—that of induction at extremely high potential. Powerful induction coils were used then as now for intensifying the current in the wire leading out from the sending station, which induces similar currents in the line at the receiving station. A regular telephone transmitter and receiver are employed.

OBITUARY NOTES.

Edward E. Quimby, an inventor, died at his home in Orange, N. J., on February 17, aged 71 years. Mr. Quimby was also a patent expert, being connected with such patent cases as the Bell telephone, the Mannesman tubes and the Harvey steel process. He was also the inventor of a screw machine used at the American Screw Company, of which concern later he was superintendent.

Mr. Thomas J. Bray, one of the pioneer manufacturers of tubes in Pittsburgh, died in that city on February 15. Mr. Bray was born in Wales but came to this country in 1852. He originated numerous devices for the manufacture of pipes, and built the original plant of Lewis, Oliver & Phillips, which is now the Pennsylvania Tube Works. He also designed the works of several other concerns.

Jerome Wheelock, a well-known inventor and mechanic, died at Worcester, Mass., on February 26, aged 67 years. Mr. Wheelock began life as an apprentice in the Taunton Locomotive Works. Some years later, when engineer at the Washburn Iron Works, he invented the steam cylinder packing that bears his name, and in the following year, with Mr. Wm. A. Wheeler, he commenced the manufacture of this packing. In 1869 he built an engine embodying the ideas developed by him for some years previous, and in 1883 he invented the "new system valves," an important departure from the usual style of construction. In 1888 a stock company was formed called the Wheelock Engine Co., which was later bought by the International Power Co. and removed to Providence. Mr. Wheelock traveled considerably during the latter part of his life.

Ziba Gay, late owner of the business of the Silver & Gay Co., North Chelmsford, Mass., died March 14, aged 79. Mr. Gay was a native of Niagara, N. Y., but he was sent to Andover, Mass., for his early schooling, and later on he went to Yale College, where he was graduated in 1846. From that time he devoted his attention to mechanics, entering the firm established by his uncle and his father, which business he subsequently continued with his partner, Harvey Silver. Mr. Silver died in 1884, and from that time on Mr. Gay conducted the business alone under the same name until a few years ago, when he disposed of it to George C. Moore, still remaining with the firm in the capacity of manager. Mr. Gay held several prominent official posts in the city in which he lived, among others that of member of the Legislature of 1874.

Bryan Donkin.

Bryan Donkin, an English engineer of prominence, died on March 3rd last, in Brussels, Belgium, at the age of 67. Mr. Donkin was the son of John Donkin, a well-known engineer, and the grandson of Bryan Donkin, whose name is connected with the perfection of certain paper-making machinery, and who in 1803 founded the well-known Bermondsey Works, England.

The late Bryan Donkin received his education partly in the University College, London, and partly in France. After completing his studies, he entered the Bermondsey Works, where he remained until 1859, at which time he was sent to Russia to superintend the erection of the largest paper mill in Europe. In 1868 he became a partner in the Donkin firm, and later on was made chairman, which latter position he filled until 1900, when he gave up the management of the works.

At about this time Mr. Donkin turned his attention to the scientific side of engine design, and entered upon some valuable research work which he persevered in practically to the end of his life. He was an advocate of great accuracy in scientific measurements and was in favor of subjecting boilers and engines to exhaustive tests for the purpose of determining their real merit and finding any defects which might be remedied.

Mr. Donkin also interested himself in the question of steam condensation in engine cylinders, in superheating and in the transmission of heat through cylinder walls. He produced in 1888 his "revealer," by means of which a definite knowledge of the condition of the internal walls of cylinders could be had. A long series of trials made by him finally established the advantage to be gained by jacketing and the benefits to be derived from the use of superheated steam in reducing initial condensation.

Mr. Donkin was also a prolific writer. Besides a great number of papers which he prepared from time to time, and which he read before the different engineering societies, he published in 1894 his book on "The Gas Engine," which is now in its third edition and also translated Diesel's "Theory and Construction of the Rational Heat Motor."

He was also greatly interested in the steam boiler, and four years after the appearance of his "Gas Engine," he published a valuable book on the steam boiler. The subjects of fuel calorimeters, centrifugal fans, the velocity of air through pipes with anemometers, etc., also attracted his attention, the results of his investigations along these lines being presented in different papers which he read before the various societies interested. He was an honorary member of the American Society of Mechanical Engineers.

TURRET LATHE FIXTURE.

ANOTHER FIXTURE FOR FORMING A PIECE OF IRREGULAR OUTLINE AND OTHER FIXTURES FOR MINOR OPERATIONS THEREUPON.

JOSEPH V. WOODWORTH.

In the preceding article on this subject, in the February issue of MACHINERY, a fixture for forming pieces of irregular outline from the bar was described, which fixture was adapted

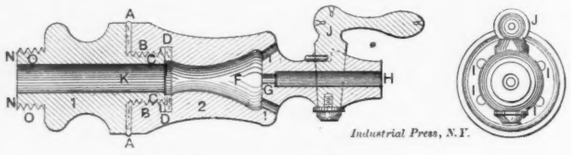


Fig. 1. The Piece to be Made.

to work having considerable stock to be removed. The tool here to be described consists of a similar fixture for use in the turret lathe for forming irregularly shaped surfaces, but from individual castings instead of from the bar, and in which less metal is to be removed.

The article for which this device was used is an improved gas stove cock made in two parts, each of which is of irregular exterior outline, as shown in the longitudinal sectional view in Fig. 1. The length of the assembled cock, over all, is 4¾ inches and the pieces are composition castings with the holes *K* and *F* cored in them. Certain preliminary minor operations are necessary on both parts 1 and 2 before the forming cutter is used, in order to form the threaded hub *C-C* on part 1 and the threaded recess *B-B* in part 2 for a means of definitely locating them on the faceplate, which operations will be described later on.

The forming cutter used for obtaining the irregular outline surface is one of the circular forming type of cutters, which is shaped entirely around its exterior surface, the cutting edge being produced by milling out a longitudinal groove on its exterior as shown in Figs. 2, 3 and 8. This is the type of cutter that may be ground and reground almost indefinitely without altering the shape of its cutting edge if the body of the cutter is properly shaped. The cutter, shown in Figs. 2 and 3, which represents the cutter used for milling the surface of part 2 of the gas cock, was made of tool steel which was annealed and bored out at *D* and a keyway let down through its entire length at *C*, after which it was driven into an arbor and the ends finished as shown at *B-B*, and the required shape turned onto the outside from end to end to templet as shown. The finishing of this forming surface is done very carefully by first roughing it out with the usual lathe tools and then using a variety of hand tools to finish it to shape. Especial care was taken to get its entire surface smooth and free from marks, and it was finished to a dead smooth finish by means of lapping with stick, emery and oil. This was necessary, as the work was required to have a high finish after being machined, and as the manner in which the cutter was presented to the work allowed of its burnishing the same as soon as the cutting edge had removed the required amount of stock and passed the center.

After being lapped the cutter was set up in milling machine and a groove milled out to form the cutting edge from *E-G* to *F*, as shown in Fig. 3, it being milled on a spiral, as shown in the face view Fig. 3, so as to cause the cutter to remove the stock progressively. In fact, the cutting edge of the cutter was finished in the same manner as a wide face milling cutter, except that the spiral is not quite as abrupt. After finishing the cutting edge as shown the cutter was carefully hardened and drawn to a very light straw temper, thus leaving it as hard as is consistent with reliable cutting.

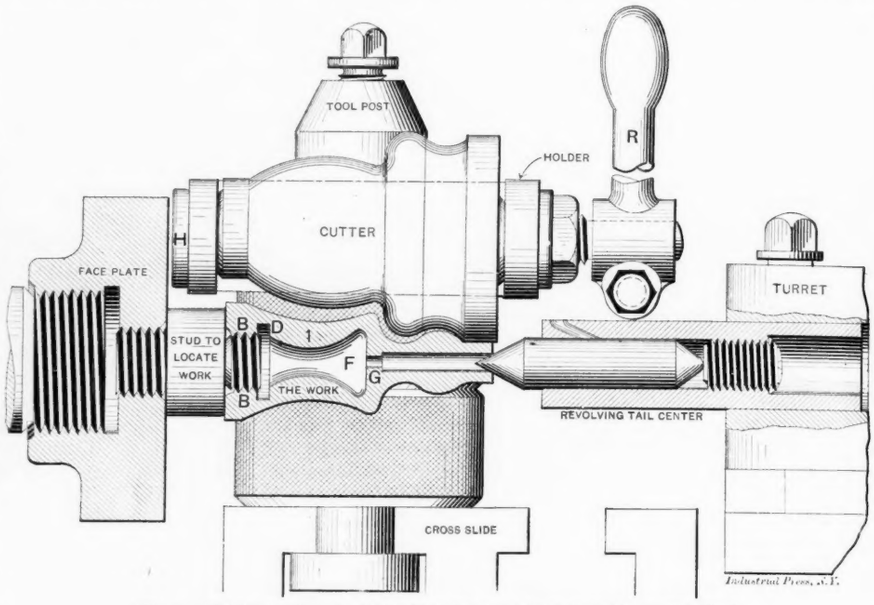
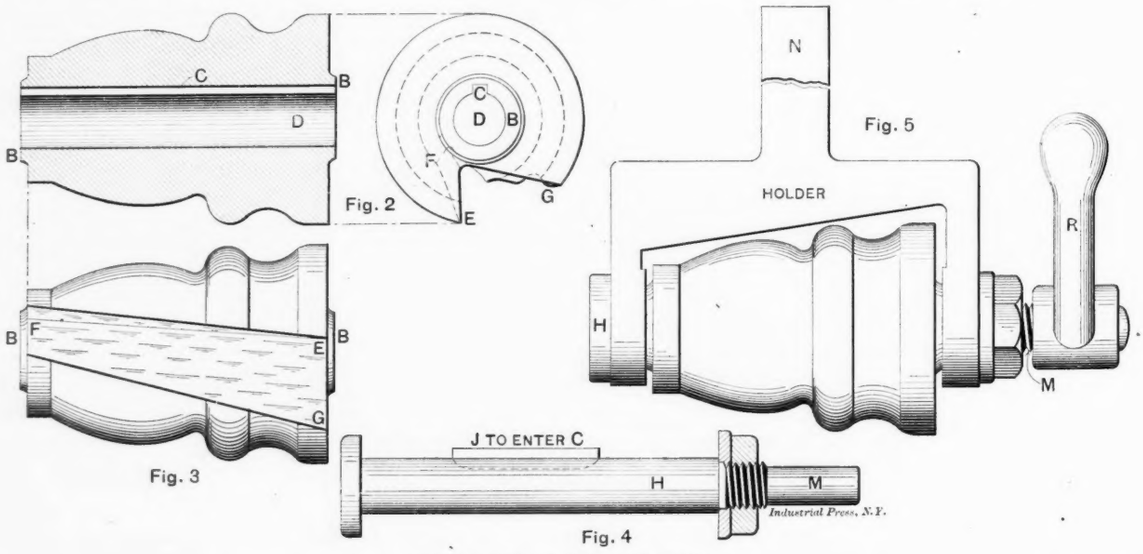


Fig. 6 Holder in place in Lathe Tool Post ready to Operate on the Work.



Details of Formed Cutter and Holder.

The cutting edge was then ground on the cutter grinder, and carefully oilstoned so as to present a smooth, keen edge for its entire length. The holder, or bracket, shown in Fig. 5, which supports the cutter and its cutter stud *H*, Fig. 4, was made from a forging with the shank *N* finished to fit the large tool-post of the turret lathe. The way in which the cutter is mounted in the holder is shown in Fig. 5, which shows a top view of the cutter in place upon its stud *H* and the hand lever *R* mounted upon the projecting end *M* of the stud.

The manner of using the fixture may be understood from Figs. 6 and 7, Fig. 6 showing a front view of both the fixture

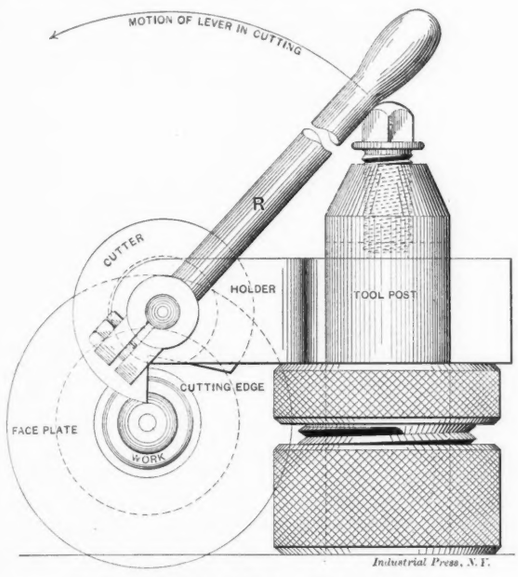
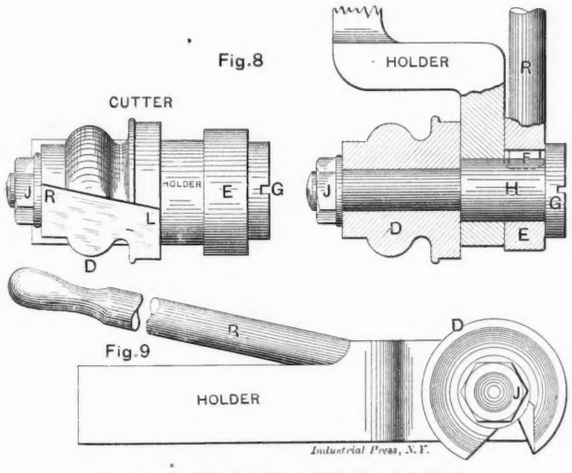


Fig. 7. End View of Holder, Tool and Work

and work in position, the faceplate and turret head, and Fig. 7 an end view toward the faceplate to indicate the manner in which the cutting edge of the cutter is presented to the work. In machining the work the handle of the cross-slide is moved by the left hand of the operator until the cutting edge of the tool is in the position against the work shown in the end view Fig. 7, and held there with the help of the stop screw of the cross-slide, while with the right hand the lever of the forming tool is pulled forward. As the cutter is slowly revolved in the holder by the pressure on the lever it cuts and removes the required amount of stock progressively, due to its spiral cutting edge, and as the cutting edge

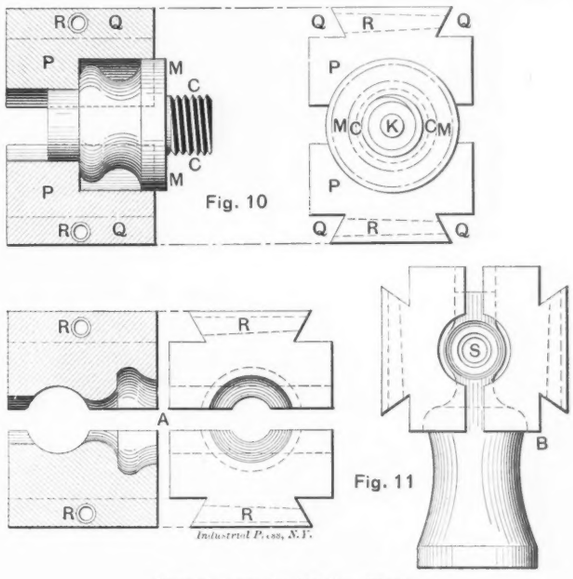


Details of a Smaller Formed Tool and Holder.

passes the center line the friction of the finished portions of the work revolving rapidly against the exterior of the cutter produces a high finish of its entire surface.

The cutter which was used for milling part 1 of the gas cock, Fig. 1, is shown in front view and section in Fig. 8, and end view in Fig. 9. This cutter was made, tempered and ground exactly the same as was the other, and its method of use in removing the metal and obtaining the burnish or polish is identical.

In connection with the finishing of these gas stove cocks other fixtures were used which may be of interest. In forming the threaded hub *C-C* on part 1, Fig. 1, a pair of slip jaws for a regular two-jaw chuck was used for chucking the work while machining. These jaws, which are shown in



Special Jaws for Holding Work.

Fig. 10, are of cast iron and are finished dovetail to drive into the jaws proper of the chuck, and are located in the proper relative positions by means of a taper pin at *R*. The way in which these jaws are constructed and finished to allow of locating the work as shown is evident from the sketch. The facing of the surface *M-M* is accomplished by means of a hollow mill, which differs from the type generally used in that it has fifteen teeth. The hub *C-C* is finished by the mill also, the thread being cut by means of a collapsible die.

In Fig. 11 at *A* and *B* are shown the slip jaws which are used for the first and third operations on part 2, Fig. 1,

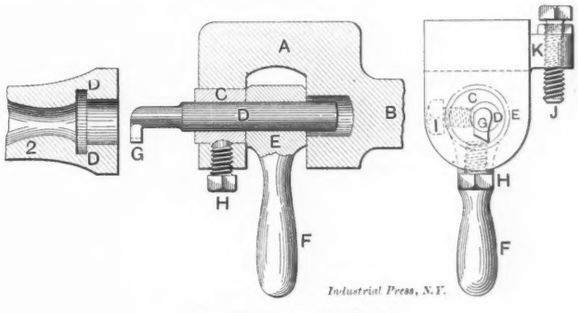


Fig. 12. Recessing Tool.

which contains the gas cock proper. These two sets of jaws are constructed similar to the first set, Fig. 10, and are used in the same way. The pair shown at *A*, Fig. 11, is for holding the casting for part 2 while the surface at *A-A* is being faced, the seat for the rubber washer let in at *D D*, and the hole at *B B* bored and tapped to fit the threaded hub of part 1. The other set of jaws shown at *B* is used for holding part 2 after being machined all over, when the taper hole for the key *J* is being let in at *S*, Fig. 11, which shows the work located within the jaws and the hole drilled at *S*. This hole after being centered in the usual manner is reamed to the required taper by means of a "floating" reamer of the usual type.

For turning the washer seat at *D D* in part 2 the special eccentric box tool shown in Fig. 12 was used, which is of an interesting construction. *A* is a holder or frame, made of cast iron, with a shank portion at *B* turned to fit the hole in the turret. *C* is an eccentric bushing located within the holder by the setscrew *H*. *G* is the cutting tool and *F*, the

lever by which it is manipulated. The depth of cut is regulated by adjusting the lever-stop screw *J*, which is let into the projecting lug *K*, as shown in the end view of the tool. In using this fixture, after the tool *G* has been entered into the cored hole in the work the required distance the lever *F* is raised slowly until it stops against the stop screw *J* which determines the proper depth of cut and then it is dropped and the tool backed out.

A novel drill jig was designed for use in boring the six inclined air-draught holes leading into the combining chamber *F* in part 2 of the gas cock. The jig is shown in plan and in sectional elevation in Fig. 13, with the work in place. As is shown, these six holes are required to be drilled at an angle with the axis of the casting and also to be equidistant, and an interesting design is the result. *A* is the body casting of the jig, which is machined on the base at *D*, and also on both sides of the projection *B*, to an angle *y* with the base as shown. The indexing device *X* and the locating stud for the work are of tool steel, hardened and

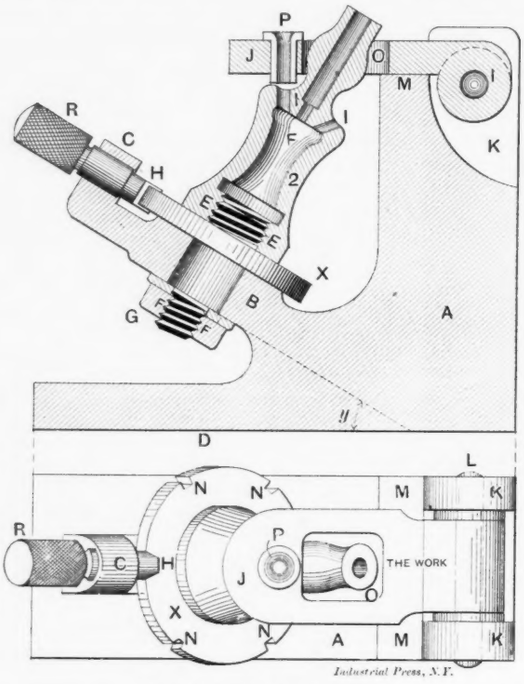


Fig. 13. Special Drilling Jig.

ground. There are six equally spaced notches in the index plate which coincide in shape with the end *H* of the index pin *R* and locate the work for the six different holes. The drill bushing *P* is located as shown in the swing lid *J*, which is hinged within the two sides *K-K* of the body casting *A* by means of the pin *L*. A hole *O* in the lid allows clearance for the work when located in the jig, all that is necessary for removal being to swing the bushing lid *J* back and unscrew the work off the locating stud.

* * *

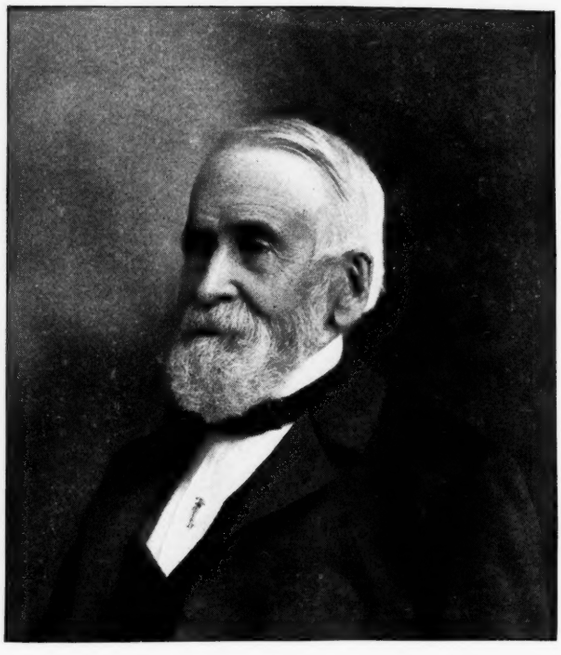
The curate of a parish in one of the iron-working districts of England tells the story in an English magazine of a laborer who fell into a furnace of molten metal, and, of course, vanished forever. The comrades of the poor fellow were greatly concerned, and did not rest till the curate had consented to bury with religious rites one of the rails into which the iron was run. The rail selected was inclosed in a wooden box, borne to the graveyard and laid solemnly in the ground.

* * *

Nitroglycerine was discovered in 1847 by Professor Sobrero, of Turin, Italy, but it was not until 1865 that its use for blasting and other rending purposes was suggested by the Swedish engineer, Alfred Nobel. The relative explosive power of nitroglycerine and gunpowder, bulk for bulk, is about in the proportion of 10,000 to 800, since one measure of liquid nitroglycerine produces over 10,000 measures of gas when detonated, and gunpowder yields only 800 measures or about one-thirteenth as much.

LORING COES.

In view of the recent change in the management of the Coes Wrench Co., Worcester, Mass., as noticed in the last number of the paper, this is an appropriate time to publish a portrait of the present owner and head of this concern, Mr. Loring Coes, who is one of the oldest mechanics to be actively engaged in business at the present time. He will celebrate his 90th anniversary on the 22d of this month. During the greater part of his long life he has been closely identified with the mechanical interests of the country and has an intimate acquaintance with the development of these interests enjoyed by but few men.



It is not known to many people that Mr. Coes is the original inventor of the screw wrench in its present form, which is the same in its general contour and outline as when first patented by him in 1841. He has continuously improved his product, and in the past year has originated several patents which will further improve the wrench, and is now arranging for their manufacture.

Mr. Coes attends personally to his interests daily, and is an active director in many outside concerns, chief among these being the local electric lighting plant and a banking house. He is also president of Loring Coes & Co., Inc., makers of machine knives.

Mr. Coes is as active as many younger men, and is an ardent fisherman and sportsman. As we write he is arranging for his thirty-eighth annual trip to the Rangeley Lakes in Maine.

Probably no tool in the market has been so fully the servant of all lines as has the screw wrench, and it is remarkable that at this time there should have been so little change, and that its original inventor should still control and improve the product of the house that he founded. The Coes Wrench is shipped to every country in the world where there are wrenches used.

* * *

A process which is said to give a beautiful frosted surface to aluminum articles is as follows: First, dip the pieces in benzine to remove all dirt and grease. Second, dip in a solution of caustic potash strong enough to blacken the metal. Third, dip in a mixture of two parts nitric acid and one part sulphuric acid. Fourth, dip in concentrated nitric acid. Fifth, dip in a mixture of equal parts of cider vinegar and water. Sixth, rinse thoroughly in clean water and dry in hot saw-dust.

* * *

The acme of fine measurements was brought to our attention a few days ago by a subscriber who had a customer call for a piece to be "5¾ inches a wee little bit more scant."

LETTERS UPON PRACTICAL SUBJECTS.

CURIOUS BREAKAGE OF A HARDENED STEEL MANDREL—BADLY CRYSTALLIZED CHAIN.

Editor MACHINERY:

Fig. 1 shows pieces of an arbor or mandrel about 5 inches in diameter and a foot long that broke after being hardened. This mandrel was needed for a "hurry-up job," and the smith was told to harden it "right off." The cut shows that orders were obeyed, as it is hardened right off in several places. When taken from the cooling bath it was to all appearances in perfect condition, and was turned over to the grinding department and placed in the grinder ready to be operated upon. The workman who was to do the job was getting

Fig. 1. A Mandrel Hardened "Right Off."

his dimensions when the mandrel broke into five pieces with a loud report, one of the pieces making a decided dent in the ceiling above the grinder. No work had been done by the man operating the grinder upon the mandrel, and it merely hung idle upon the centers. This is an interesting study of stresses set up by heating and cooling.

Fig. 2 shows pieces of a chain link, the chain being in use for about twenty years in a Worcester shop handling ordinary weights. It was needed for a rather heavier load than usual, and the superintendent struck one of the links to see if it was all right. This was done with a light hammer, and with

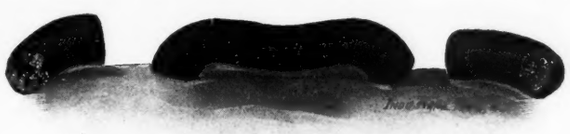


Fig. 2. A Chain Link that was not well Annealed.

the result shown. These links were as brittle as glass, and flew into pieces at the slightest blow. The chain was annealed. At the same time a piece of the broken link received a like treatment. The center piece in Fig. 2 shows that it was then possible to bend it as of old.

There is, to be sure, nothing new in this, but it may interest some of your readers. These samples are both from the same shop, and I am indebted to the superintendent for the above facts.

HOWARD P. FAIRFIELD.

Worcester, Mass.

BALL BEARINGS.

Editor MACHINERY:

The question, Why are ball bearings not more commonly used? is of frequent occurrence. The answer, if made general, is that they, like small children, require much attention and some petting, and are not suitable for hard work and rough usage. They are unlike the child in one respect possibly, which is that dirt is extremely unhealthful for them. All dust, and especially that which is gritty, rapidly destroys the balls and the surfaces on which they roll if it gets upon them. And the dust can get into the ball bearing more readily than the ordinary journal bearing, unless an effective dust shield is applied, and it does vastly more damage to the ball bearing than to the common form.

When the balls all run in the same path it necessitates the hardest and most uniform material for them to roll upon in order to prevent its grooving. The requirements are so severe that it seems impossible to secure ball bearings for heavy thrusts and even moderate speeds that are durable and reliable when the race is grooved in either one or both of the bearing plates and the balls all run in the same groove. When put to such a use as taking the thrust of the drill spindle in a power drill press one bearing with a grooved race may stand up under the work for a long time while another, made from the same materials and with equal care and skill, will groove and flake off the metal so as to destroy it in a very short time.

The form of bearing in which the ball has more than one point of contact in a groove is not the best, for at least two reasons. One of these is that the ball has a slipping and grinding action against the race instead of true rolling action. The other is that, on account of all the balls following the same path, it is much more liable to become grooved than if each ball ran in a path of its own.

The best form of ball bearing for durability is one in which every ball has its individual path that no other one encroaches upon. This is attained, in a thrust bearing, by the use of a pair of flat-sided disks, or washer-shaped rings, between which the balls roll and are held in position by a perforated disk, or pair of disks, each circular hole containing a ball. The perforations are often arranged in two spiral rows so that no two balls travel the same path. A two-disk cage is better in most cases than a single disk. The disks, when two are used, can be quite thin. They are just alike and have perforations much smaller in diameter than the balls. The latter are placed between them and projecting slightly through the holes. The disks are riveted together in this position, thus forming a cage which not only holds the balls together when in use, but also when the bearing is taken apart. The latter is of no small moment, as any one who has hunted for a lost steel ball of small size will realize.

Several instances have come to the writer's notice where bearings with multiple-path races have proved entirely satisfactory after a grooved single-path type had repeatedly failed.

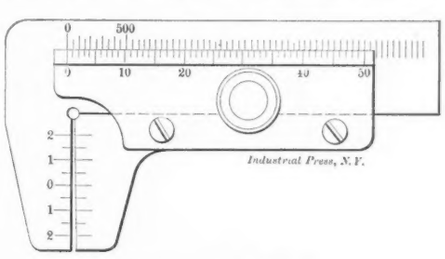
Cylindrical journals may have the balls arranged around them in a manner similar to the above by the use of a perforated cylinder with the holes for receiving the balls in two or more helical rows. A bearing of this sort, used in connection with a thrust bearing of the form described above, makes an excellent arrangement for both side pressure and thrust. A ring on the journal may take the thrust.

Worcester, Mass. FORREST R. JONES.

A DECIMAL WIRE GAGE.

Editor MACHINERY:

It is well known that the various systems of numbers used for sizes of wire, screws and other metal work are a nuisance in practice, especially as no two of the systems are alike and none are based upon any self-evident method of graduation. If it is consistent to refer to a piece of wire ⅛ inch in



Decimal Wire Gage.

diameter by some particular number, then why not designate a piece of steel 8 inches in diameter by some complex and unmeaning number? The only way to abolish this number nuisance will be for everyone to refuse to use any of the number systems and to adopt the self-evident method of exact measurement. Then if any insist on reference numbers let these be in terms of the actual measurement. Thus, a No.

120 would be a size that is one hundred and twenty thousandths of an inch.

Perhaps it has never occurred to the reader that of all the micrometers and verniers manufactured none are made to give readings in number sizes. The gages for the number sizes are of flat steel, having a series of holes, each bearing an arbitrary number, and probably no two gages have exactly the same size hole for the same number.

The accompanying sketch shows a decimal wire gage that has proved very satisfactory as an instrument for measuring wire to exact sizes, especially as an inspector's tool. It has a range of measurement up to one-half inch by thousandths, and the graduations are such that fractions of a thousandth are easily estimated. As will be seen in the sketch, the jaws taper .005 inch and have five graduations, which in reading measure .001 or .002 inch over or under the measurement as found on the vernier beam.

The vernier beam is graduated in twentieths of an inch to afford clearer readings (without the use of a magnifying glass) than would be possible with finer dimensions.

This gage is of necessity more expensive than the ordinary flat steel gage, but for accuracy and utility it is well worth the difference.

F. W. CLOUGH.

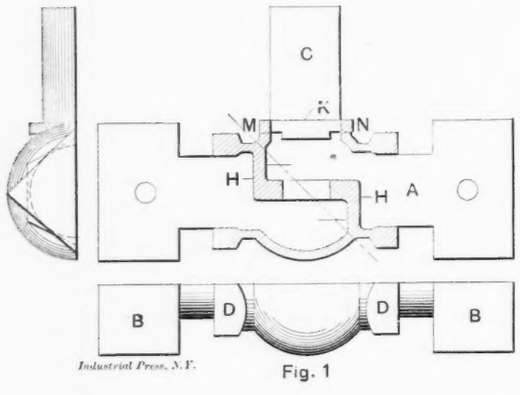
Springfield, Mass.

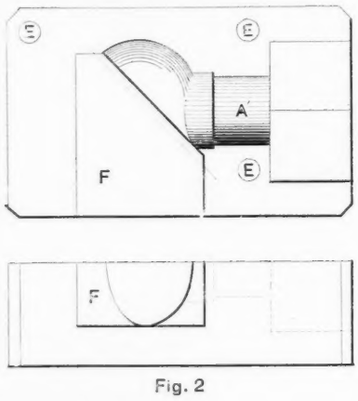
A GLOBE VALVE PATTERN.

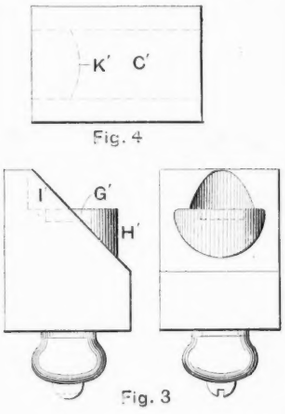
Editor MACHINERY:

As there is no pattern more unwelcome to the pattern shop than that for a globe valve and its accompanying core boxes, the suggestion of an easy solution of the problem may be appreciated.

The pattern is made in halves, and as both are alike but one half is shown, Fig. 1. The two pieces comprising the body *A* and the stem end flange with its print *C* are glued together on the line *M N*. As will be seen, both of these pieces can be turned in the lathe, the only hand work being the squaring of the sides of the prints *B B* and cutting the hexagon ends *D D*. One-half of the main core box is shown in Fig. 2. Both halves are similar, and are doweled together with the pins *E E*.







Simple Globe Valve Pattern.

Fig. 3 shows a block fitting in slot *F*, Fig. 2, and which forms the circular wall around the valve seat as well as the hole through the seat *G'*. The boss *H'* is turned to the same radius as is desired for the outside wall *H*, Fig. 1, while groove *I'* forms the core for the inside wall. A handle is provided on this block so that it can be drawn from the core box before the box itself is separated. Two cores from this box are required for each mold.

Beside these cores all that is required is a core for the stem end. This is a straight round core made by the box shown in Fig. 4. As one end of this core must fit against the spherical surface of the main core at *K*, Fig. 1, the end of the core box is fitted with the plug *K'*, the end of which is turned spherical to match the main core.

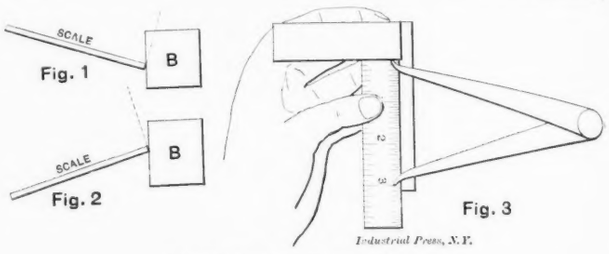
EDWARD T. WIRES.

SETTING INSIDE CALIPERS.

Editor MACHINERY:

It is customary with most machinists, when setting inside calipers to a scale, to place one end of the scale squarely against the face of some true surface, and then, placing one leg of the calipers against the same surface, to set the other leg to the required measurement on the scale. For this purpose the faceplate of a lathe is frequently used, on account of its being close at hand for the lathesman. The sides of the jaws of a vise or almost anything located where the light is sufficient to read the markings on the scale are frequently used.

The disadvantages of this method are, first, that a rough or untrue object is often chosen, particularly if it happens to be in a better light than a smooth and true one, and, second,



Method of Setting Inside Calipers,

that it is very hard to hold the scale squarely against an object. It is easy enough to hold it squarely crosswise, but it is not so easy a matter to keep it square edgewise. As can be readily seen, this makes quite a difference with the reading of the calipers, particularly if the scale is a thick one.

Figs. 1 and 2 show this effect exaggerated. *B* is the block against which the scale abuts. The dotted line indicates where the caliper leg should rest but cannot do so unless the scale is held perfectly square with the block. Fig. 3 shows a method of setting the calipers by using a small square to abut the scale and to afford a surface against which to place the leg of the caliper. The scale, lying flat on the blade of the square, is always sure to be square edgewise, and is easily held squarely against the stock of the square as shown.

This method has also the advantage of being portable and can be taken to the window or to any place where the light is satisfactory. When using a long scale the free end may be held against the body to assist in holding it in place.

Watervliet, N. Y. M. H. BALL.

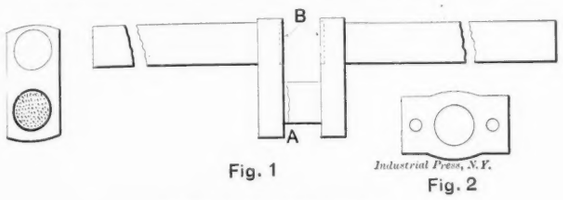
MENDING A BROKEN CRANKSHAFT.

Editor MACHINERY:

The crankshaft of an Otis hoisting engine came to our shop one morning looking as though it might have to be "mended with a new one;" but furnaces have a way of wanting things right away without waiting the length of time a new piece would require, so the foreman decided to repair it. The "old man" told me to "jump on it," and as I hadn't been out of my time very long I scratched my head several times and wondered where I was going to land when I made the aforesaid jump.

The shaft was about 4½ inches in diameter by 6 feet long, with a crank disk on one end and a pinion on the other. It had a center crank near the middle of its length, the diameter and length of the pin being about the same as the diameter

of the shaft. This pin was broken entirely in two as at *A*. We first put each piece in the lathe, holding it in the chuck and steady rest, and recessed the face of the crank about 1-16 inch deep and the same diameter as the shaft. We next drilled a 1½-inch hole through the center of the crankpin, drilling from the broken faces, and drew the two parts together as tight as a 1⅜-inch bolt would make them. After testing the shaft and finding it straight both ways we calipered between the faces at *B*, and turned and faced a piece on a 2-inch mandrel to just fit in snugly. Next the shaft was unbolted and this piece put in place. Two clamps, Fig. 2, were slipped over the ends of the shaft and drawn together firmly with



Broken Crankshaft Repairs.

1-inch bolts. We then tested the shaft on lathe centers and found it to run as true as the proverbial die. The 1½-inch hole through the pin had in the meantime been reamed with a flat drill to about 3 inches. The shaft was now mounted as one piece on the lathe carriage, a boring bar inserted and the pin bored out till a shell about ⅜ inch thick was left. A pin was then turned and pressed into this hole, going in at 20 tons, and finally the clamps were removed and the block between the faces *B* drilled out. This completed the job, which just took from 7 o'clock one morning till 7 the next morning.

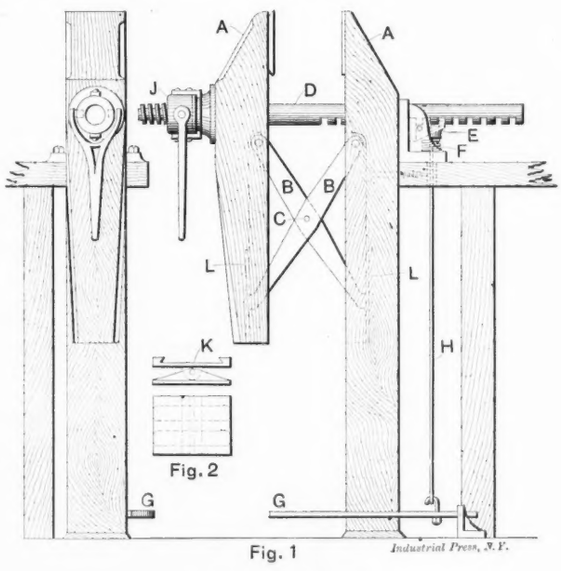
CHARLES C. STEWARD.

Birmingham, Ala.

A PATTERNMAKERS' VISE.

Editor MACHINERY:

The patternmakers' vise shown in Fig. 1, although made over twenty years ago, possesses some advantages deserving attention. Its main advantage is the quickness with which it can be adjusted to any size of work.



A Vise with a History.

Its mode of operation will be seen by reference to the figure. The jaws *A A* are made of hard wood, 4 inches by 4½ inches. The iron straps *B B* are pivoted at their upper ends to the jaws of the vise and are pivoted together at their common center *C*. Their free ends bear against iron plates *L L*, set into the sides of the jaws. The action of the straps is to keep the movable jaw at all times parallel with the fixed jaw or post. Both the movable jaw and the post are recessed sufficiently to receive the straps and thus allow the jaws to close together.

The vise screw *D* is of ash. A square thread at the front end is fitted with a handle nut and is used for short adjustments and for clamping. The back end of the screw is cut with coarse square teeth, with three of which the stop *E* is engaged when the vise is being used. This stop *E* is held into mesh with the teeth by the spiral spring *F*. When the foot lever *G* is depressed the wire *H* draws down the block *E* and the front jaw of the vise may be pulled out or pushed in at will. This affords the quick adjustment. When the jaws are pulled out a little beyond the required width the block *E* is released and, rising, engages the teeth of the screw. The work is then clamped by a few turns of the handle of the nut *J*.

On the face of each jaw is an iron plate, the edges of which are beveled to fit the dovetail on the back of the adjustable jaws. These jaws, shown in Fig. 2, have a grooved or dovetailed back corresponding to the plates on the jaws, and this back supports a jaw face which is pivoted on the pin *K* so as to allow it to adjust itself to any taper that may be on the work to be held.

One of the jaw plates is beveled on its perpendicular sides while the other is beveled on its top and bottom edge, so that the face of one adjustable jaw pivots vertically and the other horizontally. This allows the vise to accommodate itself to work of almost any shape that it may be desired to hold.

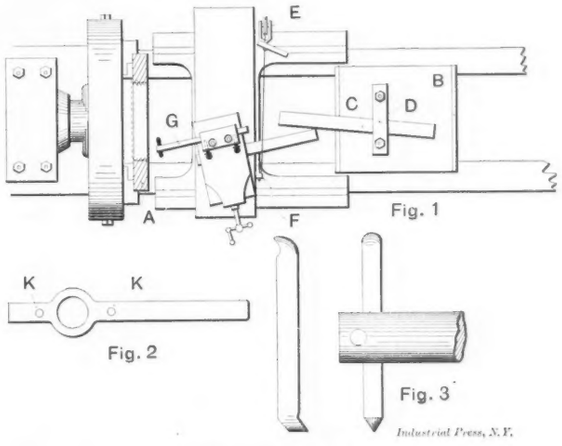
DONALD LADD.

Westfield, Pa.

RIG FOR THREADING EXHAUST FLANGES.

Editor MACHINERY:

A short time ago I had a number of 5 and 6-inch exhaust flanges to be bored and threaded with pipe threads. I found the old method of easing off the cross-feed screw as the tool goes into the hole to be a very unsatisfactory way to bore and thread the taper hole, as it did not make an accurate fit. Thereupon I rigged up the lathe as shown in Fig. 1.



Cutting Taper Threads.

A represents the flange which was held in a chuck. I removed the top of the tailstock *B*, and on the base clamped the bar of square iron *C*, using the original tailstock bolts and the strap *D*. The guide bar *C* was set at an angle to give a taper of ⅜ inch per foot, thereby causing the tool to bore a hole having a total taper of ¾ inch per foot. I disconnected the cross-feed screw and clamped the pulley *E* onto the back of the carriage. Passing over this pulley was a rope, one end of which was attached to the carriage at *F*, while the other carried a heavy weight, not shown in the sketch.

I then had a bar of 2½ by ⅝-inch flat iron forged, as in Fig. 2. The hole in the center fitted loosely over the pivot on which the compound rest swivels, while the holes *K K* were drilled to match the bolts which fasten the compound rest to the cross-slide. New bolts, however, had to be made for this purpose on account of the added thickness of the bar which was placed between the compound rest and the cross-slide, and then the three were firmly clamped together. The weight over pulley *E* kept this bar always bearing against guide bar *C*, so that the tool always fed into the hole at the

proper taper. The depth of cut was regulated by the feed screw of the compound rest.

The tool was held in an ordinary boring bar, as shown at *G*. In the end of the boring bar I used the tool shown in Fig. 3. This tool is made of square tool steel and is held in the bar by a taper pin. One end of the tool is ground for a threading tool and the opposite end for a boring tool, the cutting face of one tool being upside down in relation to the other.

Now when the boring is finished all that is necessary is to loosen the setscrews holding the boring bar and rotate the bar half a turn, which brings the threading end of the tool into position. This effects a great saving of time over that which would be required to change tools.

Mahone Bay, N. S. ROBERT B. WESTOVER.

CUTTING RIGHT-HAND WORMWHEELS WITH A LEFT-HAND HOB.

Editor MACHINERY:

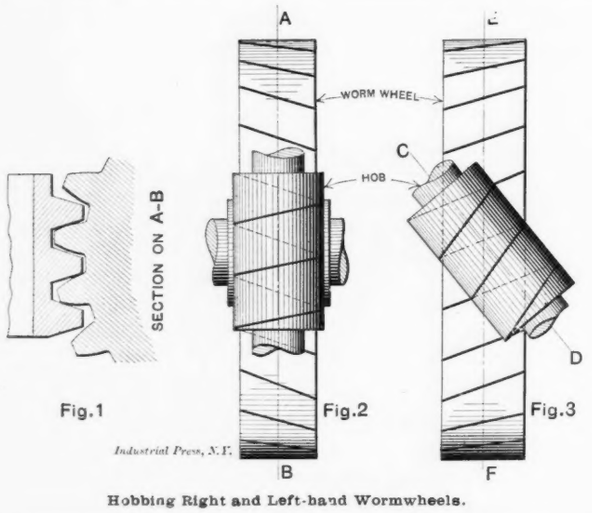
We had a number of wormwheels to hob, some right-hand and some left-hand, and not knowing any better at the time we made both a right and a left-hand hob for the cutting. The pitch was 8 (diametral), the pitch diameter of wheels 7¾ inches, and the consequent number of teeth 62. The pitch diameter of the worm was 2 inches, and the included angle 30 degrees.

The blanks were sized and stocked, and after several right-hand wormwheels had been hobbed, much to the surprise of the boy at the milling machine a left-hand one was put in, the table swung around to the proper angle and we proceeded to hob a left-hand wormwheel with a right-hand hob. This may be common practice in some shops, but it was new here, and we now have a hob for sale. The purchaser can have his choice, right or left hand, and we will guarantee it to cut either pitch, one as well as the other.

I mail you a section of the rim of a right-hand wormwheel as hobbed by a left-hand hob. It was used as an experiment, to prove my theory, before trying it on a finished wheel. Had the width of face been correct the cut would have been smooth. The bright spots show the contact with the worm in action. J. C. WHITE.

Decatur, Ill.

[The segment of the wormwheel sent by Mr. White bears no evidence of having been cut by an unusual method, and no one could tell by the naked eye whether the teeth were hobbed with a right-hand or a left-hand worm. The bright spots referred to in the letter are uniformly distributed and



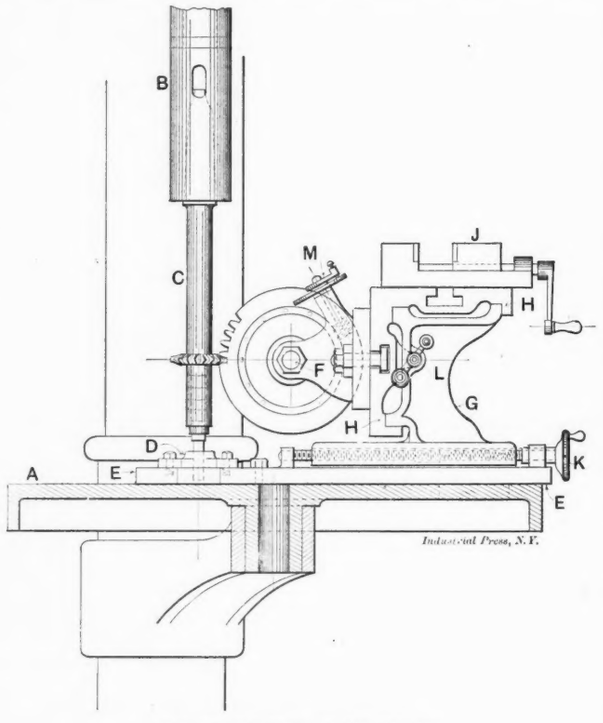
Hobbing Right and Left-hand Wormwheels.

show that the worm thread had a good contact with the teeth of the wormwheel. Practically considered, it appears to make no difference whether a wormwheel is cut with a right or left-hand hob, and with ordinary pitches and sizes of teeth it would be difficult to detect any error arising from the use of a hob of the wrong hand. Theoretically, however, the teeth will not be of the correct shape unless the cutting is done with a hob of the same pitch as the teeth of the wheel. This is illustrated in the accompanying sketches, where Fig. 2 shows a right-hand hob in mesh with a right-hand wormwheel. The axis of the hob is at right angles to the axis of the wormwheel, and if a section were taken on the line *A B* the teeth of the hob would appear like rack teeth and the teeth of the wormwheel like spur-gear teeth in mesh with a rack. This is shown in Fig. 1. When a worm and wormwheel are cut as they should be, the sectional view of their teeth, taken in a plane at right angles to the axis of the wormwheel, will appear like correctly formed rack and spur-gear teeth. But if this sectional view does not contain outlines of teeth that are conjugates of each other—in other words, that are properly formed—there has been some error made. Fig. 3 shows a right-hand hob cutting left-hand teeth in a wormwheel and it will be evident that the sectional view would have to be taken on the line *C D* in order to show outlines of conjugate teeth. This is the position of the hob while it is doing the cutting, and a worm would have to occupy the same position as the hob to run perfectly with the wheel. When the left-hand worm that is to run with the wheel in Fig. 3 is placed in position, however, its axis will be parallel with the line *E F*, and it is evident that its teeth will not mesh correctly with the teeth of the wormwheel. The sketches, of course, are drawn in an exaggerated manner in order to better show the point it was desired to bring out.—EDITOR.]

A MILLING ATTACHMENT FOR THE DRILL PRESS.

Editor MACHINERY:

Everyone knows that a milling machine is almost indispensable in a machine shop, but it is sometimes impossible for a small shop to add so expensive a machine when first starting out. The writer was at one time connected with such a shop engaged in building small gasoline engines, for which



Details of Drill Press Attachment.

a large number of cut gears were required. These, after being turned, were sent to an outside shop to be cut, and it occurred to me that a lathe or drill could be fitted up in the shop to do this work. The drill press attachment shown in the sketch was therefore constructed.

A is the table of a drill press; *B* is the spindle carrying the arbor *C*, which may be fitted with any kind of a milling cutter. The lower end of arbor *C* runs in the adjustable bearing *D*. The bed *E* of the attachment is fitted with a carriage *G*, which is fed in or out by the screw and hand-wheel *K*. On this carriage is a table *H*, which slides at right angles with the movement of the carriage, and carries the

centers *F* and the dividing head *M*. The feed of this table is operated by the handle *L*. We thus had all of the feeds found on a milling machine—the carriage feed corresponding to the vertical, the table feed to the horizontal, and the drill press feed to the cross feed. These are, of course, all hand feeds, but they could be arranged for power with a little complication. If an accurate dividing head is provided exceedingly good results can be obtained with this attachment.

This fixture is also very handy for end milling, as a vise may be mounted on the table as shown at *J;* and last, but not least, it is a very handy attachment for all kinds of drilling.

M.

THE CARE OF PATTERNS.

Editor MACHINERY:

Patterns that are in regular and constant use ought to be returned from the foundry at quite frequent intervals, and in addition to any other needed repairs, should receive two or three coats of varnish. For lack of such slight attentions, many patterns become wrecks long before their usefulness would otherwise have ceased.

There has been some discussion lately in some of the mechanical papers, as to what is the best method to use in varnishing patterns. The common practice, hereabouts, is to first give them a moderately thin coating of dead black shellac varnish, which, after it has got thoroughly hard and dry, is rubbed down with No. 0 or 00 sand paper; then holes are waxed or puttied up, small wax or putty fillets are run, and then a couple of coats of good luster black shellac varnish put on. In New York or in Philadelphia I think it is customary to use orange shellac instead of black; I doubt if there is any particular advantage in this, however.

For this work the patternmaker should be particular to keep his hands very clean while constructing the pattern, or the work would get so very soiled that it would look badly when finished. If the pattern was made of mahogany, I fear it would show many dark streaks, if made by some of us whose hands perspire much in warm weather.

At one time we had occasion to use some close-grained hardwood for some patterns, and we chose either straight-grained cherry or rock-maple, and found that it was impossible to make the black varnish stand much usage. It seemed to peel off, or wear off, very easily, so we had recourse to dry white lead mixed with the orange shellac, which gave a pink tint to the work. Probably, by the use of suitable pigments, almost any desired shade could have been produced. We found this to be the most wear-resisting of anything we have ever tried. The most serious objection to its use seems to be the "cuss words" emanating from those working who are unfortunate enough to have to make alterations on such patterns, for the compound forms a very hard, sheet-iron like coating, which plays havoc with edge tools.

Since any varnish we may use merely forms a thin skin, or coating, on the surface, I have often wondered why it would not be a good idea to first give the patterns a coating of linseed oil that would strike in deep, and thus tend to better preserve the wood from shrinking and swelling, and then to varnish them as is usual.

One thing I have noticed is that patterns returned from some foundries, where they have been cast from only a dozen times, are in much worse condition than similar patterns returned from other foundries where fifty or one hundred castings have been made. I well remember one notable instance of this kind. Thinking that, if I should "jump" on the foundryman, he would deny any wrong doing, I took a different method and gradually drew him out. I said to him: "I should think you would have turned the hose on those patterns, instead of leaving them covered with damp sand." "That is just what I did," he replied. "I gave them a thorough washing." "Well, then," I said, "why didn't you stand them up against the steam pipes and dry them off quickly, instead of letting the water remain on them and soak into the wood," and he replied that he did, and that the pipes were nice and hot, and he gave them a thorough drying, letting them stand there over half an hour, "so they would get dry clear way through"—and I thought of all those glue joints!

In other instances it would seem as though the patterns, when being returned from the foundry, were laid in the bottom of the wagon, and the castings then piled on top, thus avoiding the danger of any of the patterns dropping off and getting lost, which, of course, would be deplorable. Incidentally the patterns got a few bruises, where the teamster did not drive very carefully over the cobblestone paving, but the castings arrived without serious damage, which appeared to be the main thing to consider. There would have been evidence of the possession of brains, had the driver wrapped those patterns up in an old blanket, and tucked them up forward under the seat, but then he probably "wasn't paid for furnishing brains," as the Irishman said when expostulated with one day for working out in the hot sun at the risk of injuring his brain. "Begob," he said, "do you suppose I would be doing this kind of work if I had any brains?"

W. A. SYLVESTER.

CASES FOR KEEPING BOLTS, WASHERS, ETC.

Editor MACHINERY:

It is well known that much time is lost in a machine shop owing to the fact that bolts, washers, clamps, etc., are usually left where last used, and, in consequence, when again desired considerable time is spent in hunting them up. To avoid this if one or two cases, similar to those shown in Fig. 1, are provided they will be found of great service.

In the case shown the uprights and shelves are of 1½-inch lumber, the back of ⅞ inch. On the front of each shelf is a strip of wood projecting about ¾ inch which keeps the bolts,

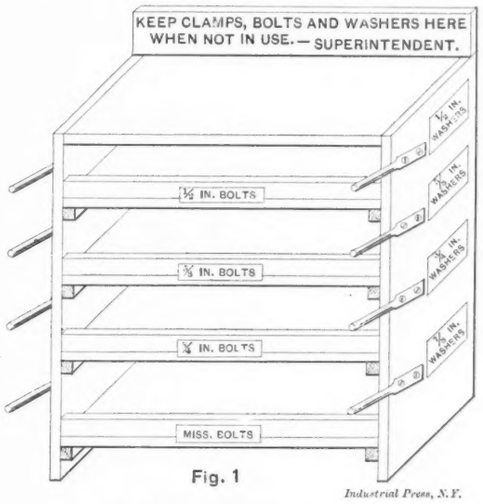


Fig. 1

Industrial Press, N.Y.

Fig. 2

A Convenient Rack.

etc., from falling off. On the sides of the case are fastened a number of rods, shown in Fig. 2, for holding washers. On the front of each shelf and below each rod is tacked a card bearing the size of the bolt or washer that is to be kept on that shelf or rod. If a sheet of mica or of transparent celluloid is tacked over each card it will prevent it from being soiled or defaced. A strip of wood along the top of the rack bears the inscription: "Keep Clamps, Bolts and Washers here when not in use.—Superintendent."

These cases are much appreciated by the workmen, who follow the directions without any trouble.

H. R. ASH.

Chicago, Ill.

REGARDING CHUCK WRENCHES.

Editor MACHINERY:

In the notes on the Skinner Chuck Company's shop mention is made of the one advantage possessed by lathe chucks having projecting screws over chucks having flush screws. That is, the single-end wrench used on projecting screws affords a greater leverage for the same weight and length of handle, and is handier to use than the double-end wrench necessarily

employed on the ordinary flush-screw chuck. The double-end wrench is awkward and unhandy to use, especially when a piece larger than the chuck is being gripped. On the other hand we all appreciate the danger of lathe chucks having projecting screws and many can testify to it from personal experience in which they have lost generous patches of skin or have received more serious injury by coming in contact with the screw heads of a rapidly revolving chuck.

What I wish to suggest is that the flush-screw chuck be made so that it will have the advantage of the projecting-screw type, without its dangers. A single-end wrench could be used just as well on flush screws as on projecting screws provided the counterbore around the squared ends was made large enough to take in the end of the wrench, a feature of contruction that so far as I can see would be entirely unobjectionable. I have seen a single-end chuck wrench rigged up for a flush-screw chuck by cutting the wrench in two and drilling a new hole for the handle close to the end having the squared hole. The handle was then put in so that it projected on one side of the wrench only, thus making a poor sort of single-end wrench, but one that was better adapted to rapid chucking than the ordinary form of double-end wrench. By all means let us have flush screw chucks adapted to the use of single-end wrenches.

F. EMERSON.

Newark, N. J.

RECENTERING AN ARBOR.

Editor MACHINERY:

I was recently required to fit a tool-steel center into one end of a large special arbor, the original center of which had never been properly casehardened and had given out in a short time. The arbor is used on very fine work, and my instructions were to make it run perfectly true. As I succeeded in doing a first-class job, the method I used may be of interest to some one.

I first placed the arbor in the lathe, with one end on the live center, running the body of the arbor in the steady rest. A piece of thin, hard sheet brass long enough to encircle the arbor was used as a protection from the jaws of the steady rest, one end being bent to keep it from turning with the work. Hold-back bolts were used to keep the arbor against the live center. A tapered hole was then bored in the end of the arbor 1½ inch deep and slightly recessed at the back, care being taken to have a round, smooth hole.

Industrial Press, N.Y.

New Center for Arbor.

The steady rest was then removed, and a piece of tool-steel 6 inches long was placed on the centers of the lathe, the ends faced off, and one end turned back for about an inch. The steady rest was then called into requisition again, running one end on live center and the end which was turned, in the steady rest, using hold-back bolts as before.

The center was then cut into the end with a centering tool to the required size and polished very smooth, after which the steady rest was taken off and the piece placed on the centers of the lathe, and one end turned to fit the tapered hole in the end of arbor, allowing .005 to grind off after being tempered.

The piece was then partly cut off as shown in the sketch, and after being hardened and ground to size on centers was easily broken off and driven in the end of the arbor. The arbor when placed on centers ran dead true and was pronounced very satisfactory.

R. B. CASEY.

Schenectady, N. Y.

CUTTING KEYWAYS AT RIGHT ANGLES.

Editor MACHINERY:

Having recently to cut two keyways at right angles in a shaft and cam, I used the method shown in the sketches which may be of use to some other planerman having a similar job to do.

Fig. 1 shows the method for cutting the keyways in the shaft. The single arm spider *a* was held fast on the shaft by the setscrew, and the adjusting screws *b b* were set so that the distances *c c* should be equal to the distances of the center of the shaft from angle plate *d* and from the planer platen respectively. Having cut one keyway in the position shown the shaft and fixture were turned, as shown by the dotted lines, and the second keyway was cut, necessarily at right angles to the first.

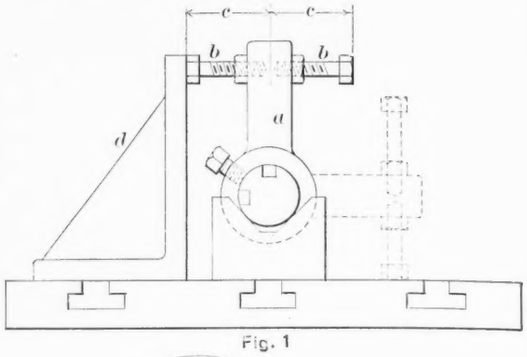


Fig. 1

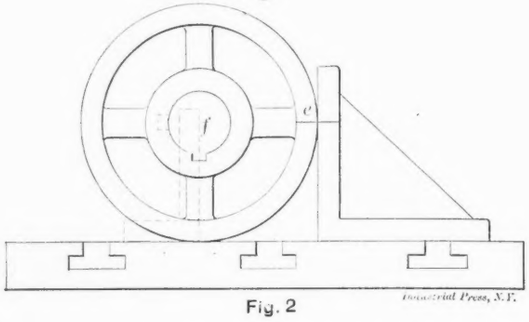


Fig. 2

For cutting the keyway in the cam, Fig. 2, the line *e* was laid off with a surface gage at exactly the same height as the center of the cam *f*. The first keyway having been cut, the cam was turned so that the line *e* would "square up" with the center of the cam and the second keyway was planed.

T. J. M.

Thompsonville, Conn.

* * *

PRACTICAL ARBITRATION.

A hint for the settlement of strikes and other labor troubles, arising from a disagreement or misunderstanding between employers and employees, is to be found in the means adopted for the settlement of the great steel fight of 1900, when Messrs. Carnegie and Frick were at odds. Word reached New York that the papers for the famous suit were to be drawn and that a conference was called at Atlantic City. Lawyer James B. Dill was summoned, and the simple plan used by him for the settlement is thus described in the *World's Work*: In the words of an attendant at that memorable meeting: "Dill took in the situation at a glance. Going straight to Mr. Carnegie, Dill asked him to write out his views and note what he wanted. He did so. Mr. Frick did the same thing. Taking both memoranda, Mr. Dill locked himself in his room and did some hard thinking. Brushing aside non-essentials, he busied himself with what was vital. Then he got both gentlemen to agree to let him settle the dispute, and within a few days he showed each how the company could be recognized on lines satisfactory to all. It meant several millions more for both Mr. Carnegie and Mr. Frick; so Mr. Dill's suggestion was accepted as the solution of a very difficult problem. Had the fight continued and the whole matter been rehearsed in the courts no one knows how serious the consequences might have been."

* * *

The *Aluminum World* says that Dr. Goldschmidt's thermit powder for alumino-thermic welding of iron, etc., is furnished by a Paris firm in lots of 50 kilos (110 pounds) at 2.75 francs (55 cents) per kilo (25 cents per pound). The ignition powder costs 10 francs per kilo (90 cents per pound).

NEW TOOLS OF THE MONTH.

A RECORD OF NEW MACHINES, TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

SELF-OPENING AND ADJUSTABLE SCREW CUTTING DIE-HEAD.

In the March issue an improved collapsing tap made by the Geometric Drill Co., New Haven (Westville Station), Conn., was illustrated and described. The accompanying cuts show exterior and sectional views of their improved self-opening die-head for screw cutting.

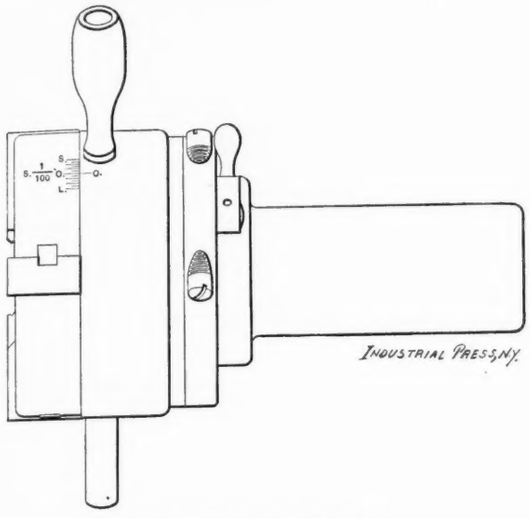


Fig. 1. Side View of Die Head.

The illustration, Fig. 1, is the exterior view of the self-opening die-head, showing the adjustment scale, micrometer adjusting screws and the lever for partially opening the die for the first pass when cutting screws with two passes of the cutters. This feature is of considerable importance when cutting first-class screws, especially those of large diameter and coarse pitch, as a smoother and more accurate thread can, of course, be cut by two passes of the die than by only one. The lever referred to, when thrown into a forward position, opens the die sufficiently so that by the first pass of the dies most of the stock is removed; thrown into the second position the thread is cut to full depth.

In Figs. 2 and 3 the various parts are marked for convenient reference. *A* is the shank, *B* the cam ring for opening and closing the die, *C C C C* are the chasers, *G* is the ring carrying the chasers and *D* is a coil spring for retracting the die ring *B* when tripped at the end of a thread. The ring *B* carries a handle *K* and is also shown bearing a pin *L*, but this is only employed on turret machines when it is desirable to have the die closed automatically by coming in contact with an exterior trip instead of being closed by hand by means of handle *K*, which is the ordinary method.

The end view, Fig. 2, shows the shape of the cams *E E E E* on the cam ring which engage the slots *e* in the cutters. When the handle *K* is thrown to the extreme right the cutters are moved outwardly until the cams have passed out of engagement with the slots in the cutters. Then the cutters may be removed from the head without tools. To facilitate assembling the cutters and to readily permit the removal of one or more cutters without disturbing the rest, frictional detents *M M M M* are provided, which consist of small pins moved outwardly a short distance by coil springs. When the cam ring has been shifted around sufficiently to permit the removal of the cutters the detents are directly beneath them, and by the slight frictional resistance due to their pressure on the cutters they prevent them dropping out, yet do not interfere with their easy removal.

The die ring *G* is flexibly held so that the cutters may follow the piece being threaded even if it is not exactly concentric with the die. *G* is made with an inwardly projecting part having an internal shoulder against which the spring *F* abuts, holding it normally in the position shown. The part *H* which screws into the shank carries a shoulder for the opposite end of the spring. This construction allows the die ring to "wabble," as it were, when necessary to follow the shape of the part being threaded.

The micrometer adjustment is effected by manipulating the screws *J J'*. By loosening one screw and tightening the other the 0 mark on the cam ring may be shifted in either direction so as to make the die cut large (*L*) or small (*S*) as may be required. When the adjustment screws are changed the position of the ring *I*, carrying the catch holding the cam ring, is shifted a corresponding amount and also the lever controlling the partial opening of the dies for cutting screws with two passes of the dies. The movement controlled by the lever is, however, unchanged except that the thread will be relatively larger or smaller as the case may be.

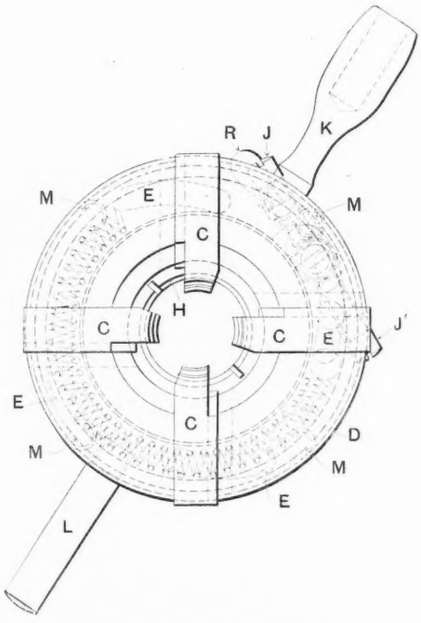


Fig. 2. End View of Die Head.

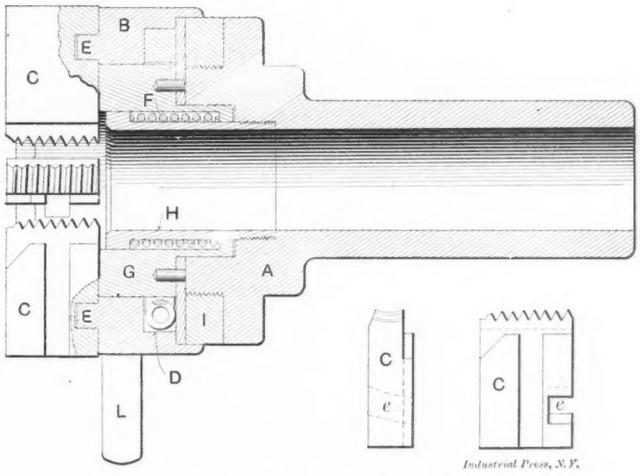


Fig. 3. Sectional View, showing Details.

THE IMPROVED ACME BOLT CUTTERS AND NUT TAPPERS.

The Acme Machinery Co., Cleveland, Ohio, the well-known manufacturers of bolt cutters and nut tappers, have for some time past been making and experimenting with various designs of automatic bolt threaders and nut tappers, with the idea of perfecting the same and placing upon the market, but not until the present have they reached the state of perfection desired to make the machines perfectly automatic and reliable. Many difficulties were necessarily met in the designs of such automatic machinery, but these have finally been overcome in a way to make them very reliable and even self-protective, for they throw themselves out of gear if defective or improperly sized pieces are presented to be machined, and, furthermore, great rapidity of work has also been incorporated in the design. The bolt threaders have a capacity of threading 8,000 ⅜-inch bolts in ten hours, while the nut tappers will tap 16,000 ⅜-inch nuts in ten hours, and the attendance required is so small that one man can easily attend to ten of the machines of either kind.

The engraving, Fig. 2, presents an exterior view of the improved nut tapper as now made. It consists in general of a nut hopper and feeding mechanism which feeds the blank nuts down into nut holders in readiness for the taps, which then come up from below and tap them out. The taps are arranged so as to reverse and back out of the nuts quickly after tapping, and, furthermore, their driving connections are so arranged as to immediately reverse and back the tap down the instant a nut without a hole or any other obstruction is met, thus preventing the breakage of taps.

Fig. 1 is a side elevation in section of the nut tapper showing the course of the nuts and the tapping mechanism. The hopper, or nut receptacle, *H*, which is divided into six parts by partitions, receives the blank nuts and, by means of the stationary plate at its bottom with a hole in one side of it, discharges a portion of them at intervals onto a revolving or centrifugal plate beneath. This centrifugal plate works

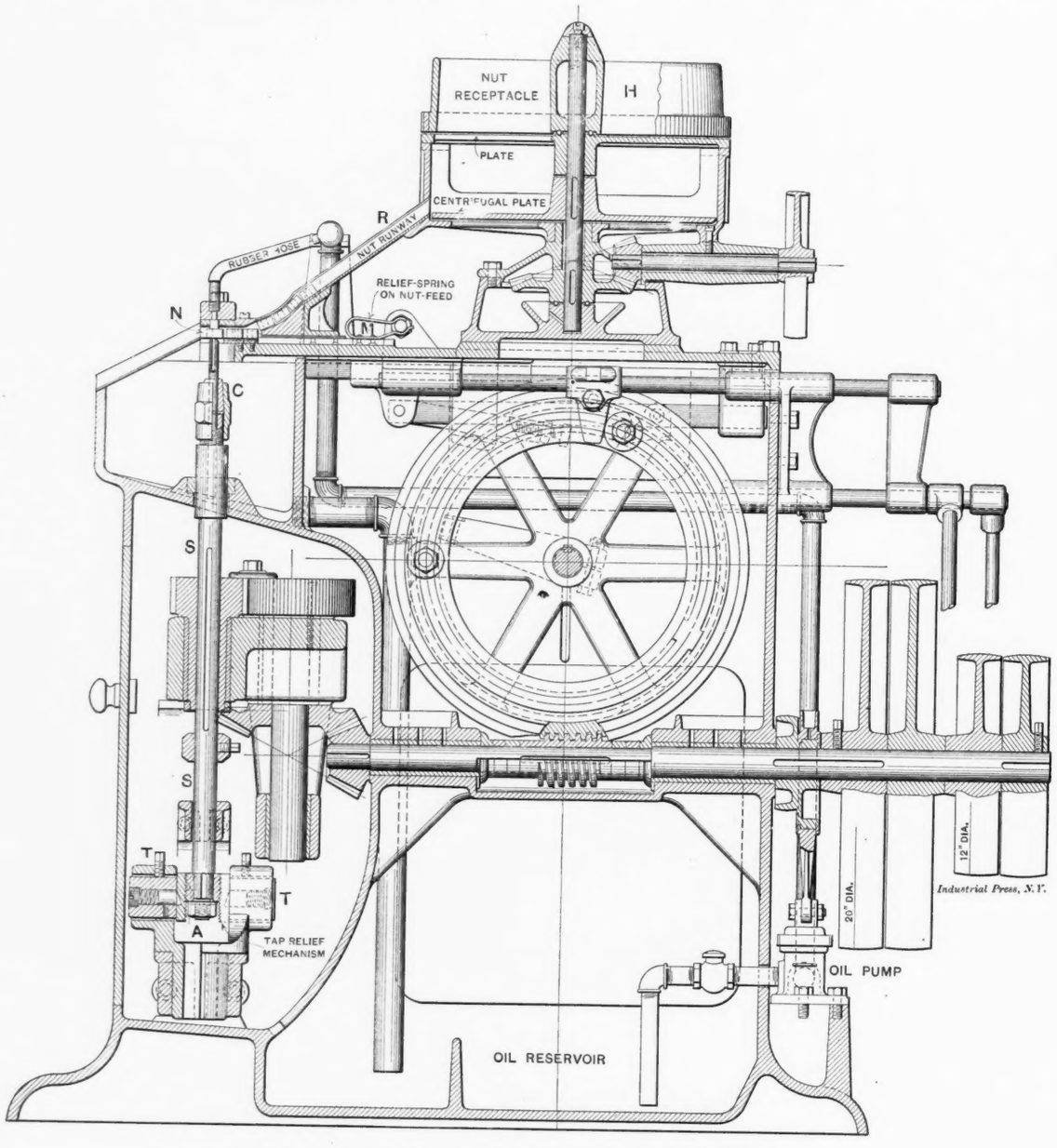


Fig. 1. Sectional View showing Details of Automatic Nut Tapper.

the nuts to its outer edge where they find entrance to the inclined nut chutes, *R* that lead them down to the taps. At the bottoms of these chutes is the mechanism *M* for rejecting the threaded nut from the nut holder and putting in its place another blank for the next operation, and the mechanism is fitted with a relief spring attachment for the purpose of throwing any particular chute out of gear if a ragged nut or piece of scrap gets in the way in it, so that there is no danger of breakage.

There are four nut runways leading to four nut holders *N*, and the tapping is accomplished by four vertical tapping spindles *S* which are arranged to run upwards into the nuts, guided by lead screws *A* running in pairs of split nuts *T* at

the lower ends of the tapping spindles. When the machine is in the motion for tapping, the tapping spindles are driven slowly upward so as to follow the tap in its cutting, but when the nut is tapped and the machine reverses it is geared so as to cause the taps to back out of the nuts with double the speed of entering. The split nuts *T* at the bottoms of the tapping spindles are, as mentioned before, so arranged, by being held in position by spring pressure only, as to begin to travel downwards as soon as the taps reach an obstruction of any kind, as a nut blank without a hole or piece of scrap.

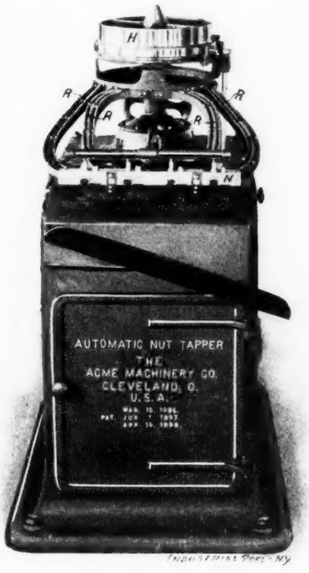


Fig. 2. View of Automatic Nut Tapper.

This prevents breakage of the tap, but the instant the obstruction is ejected from the nut holder the mechanism is automatically replaced in position to continue tapping as before.

The bed is made in box form, the nut-feeding mechanism being placed as shown outside and on top, while the working mechanism is placed inside and separated by partition from the part where the tapping lubricant is applied so that the oil used on the taps may not get to the working parts. The tapped nuts before being ejected to an outside receptacle are allowed to remain a moment on a draining plate which delivers the oil drained therefrom to a basin below. Oil is led from an oil pump through pipes directly to the taps so that they are flooded while in operation.

Fig. 3. View of Automatic Bolt Threader.

Fig. 3 is an exterior view of the bolt-threading machine. This machine so closely resembles the nut-tapping machine that it may be understood from reference to Fig. 1, the main differences being the use of a die holder at *C* instead of a tap chuck, and also, naturally, a feeding mechanism of different design to accommodate bolts instead of nuts. The feeding device consists of a hopper for the bolts at the top of the machine and means whereby the machine automatically arranges them in two runways, *R* in which they hang downwards by their heads, and they slide down these inclines by their own weight to a mechanism which feeds them into the vises or holders for cutting. These vises close automatically onto the bolts just after they have centered themselves over the die heads; then the feeding mechanism immediately recedes and the die head rises and cuts the thread. Otherwise the action of this machine is similar to the other. The feeding mechanism expels the threaded bolts and will throw a spindle out of gear if a bent bolt or obstruction is met, and the same arrangement of split-nut lead-screw feed is applied with its automatic relief. The die heads and dies used are of the solid adjustable type and are flooded with oil.

The capacity of both of these machines is work from 5-16 to ½ inch, and bolts of a length up to 4 inches. The manufacturers are now devoting an entire floor to the production of these machines, as they have many orders ahead for them.

UNIVERSAL MILLING MACHINE WITH POSITIVE FEED.

The Brown & Sharpe Mfg. Co., of Providence, R. I., have recently placed upon the market a new design of universal milling machine which is shown by accompanying engravings, and embodies many features of interest.

Attention is called to the entire absence of the usual feed pulleys and belts, thus eliminating the overhanging brackets and other appurtenances necessary to a belt driven feed.

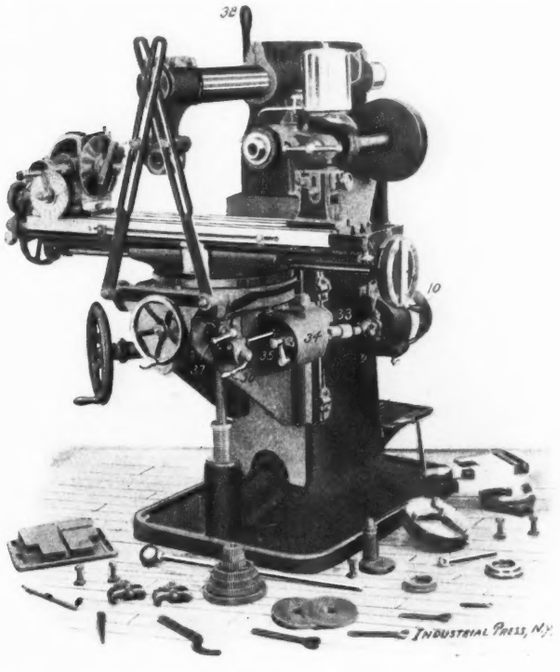


Fig. 1. Brown & Sharpe Universal Milling Machine.

The variable feeding mechanism, being an entirely new feature, a detailed description will be of interest. It is driven from the main spindle of the machine by a chain and sprocket wheels. The gearing of the mechanism itself being spur gears and the drive to the feed clutch gears in the knee being also by spur gears, all with properly arranged bearings, the loss of power by friction is slight. It is designed to obtain a wide range of feeds, varying in geometrical progression, fully covering all the requirements of modern milling machine practice. The mechanism, as a whole, is self-contained and care has been taken to insure ease and quickness of manipulation.

The drive is from the main spindle of the machine by chain to a sprocket wheel on the rear end of feed box 10, Fig. 1. In Fig. 2, which shows the feed box in detail, the sprocket wheel appears at 1, and is keyed to shaft 2 which it drives. This shaft carries the two main driving gears 3 and 4, the gear 4 running directly upon the shaft and the gear 3 upon the hub of this gear, these in turn being driven by the clutches 5 and 6.

The clutches are operated by a lever on the outside of the casing of the feed box. When thrown over against a stop pin in one direction, it engages clutch 5 with gear 3, making it the driver and giving a fast series of speeds tabulated on a plate attached to the casing; and when in the reverse position clutch 5 is thrown out and clutch 6 engages gear 4 and a slow series of speed is obtained.

The power is transmitted from either gears 3 or 4, Fig. 2, to the intermediate shaft carrying the two sets of gears 11, 12, 13 and 14, 15, 16, which are keyed into position on the shaft, and transmit the power to the series of loose gears 17, 18, 19 and 20, 21, 22 that are mounted to run one upon the other, as shown in Fig. 2. The gears 17 and 22, Fig. 2, run directly upon the shaft 2a, that transmits the power to the table through the telescopic shaft 33, Fig. 1. This method of mounting insures long bearing surfaces for each gear, and at the same time gives compactness to the mechanism. As the gears all rotate in the same direction, the motion between the bearing surfaces is a differential one due to the difference of speeds between the gears.

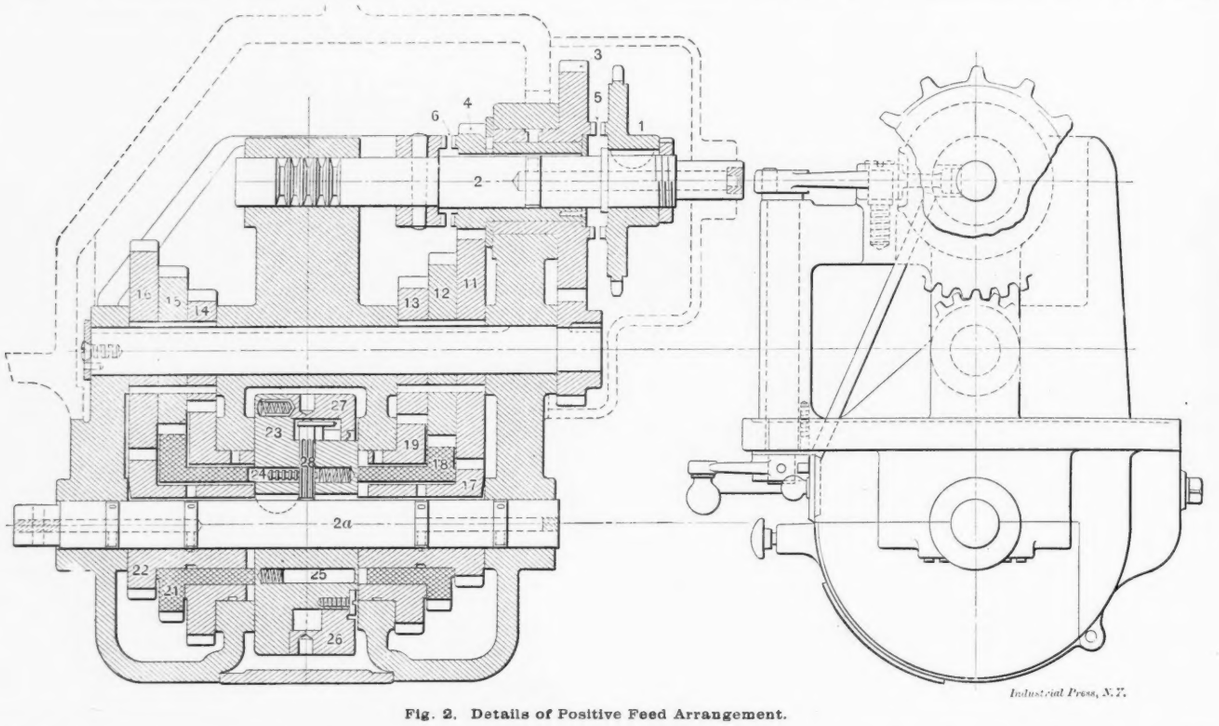


Fig. 2. Details of Positive Feed Arrangement.

The variation of feeds is obtained by engaging the different gears of the series 17, 18, 19, etc., Fig. 2, with the shaft 2a. This is effected by means of six locking pins carried by the disk 23, which is keyed to the shaft 2a and rotates with it. Two of the pins are shown at 24 and 25, Fig. 2. Each of the pins is so located as to engage one of the gears of the series, recesses being provided in the hubs to receive them. These pins have rack teeth cut upon them and are moved out or in by means of radial pins upon which pinion teeth are cut to mesh with the rack teeth. One of these radial pins or pinions is shown at 28, Fig. 1, and on its upper end is a lever, 27, by which the pinion can be rotated sufficiently to move the locking pins the required distance. All of the six pinions are similarly constructed and for convenience in operating there is an index disk, 26, Fig. 1, which can be rotated by hand relative to the locking pin disk, 23. On its inner surface is a recess into which the different pinion levers, 27, may drop when the index disk is brought into the right position. The locking pin disk, 23, is figured 1, 2, 3, 4, 5, and 6 on its periphery to correspond with the feed table, and the index disk is plainly marked with a zero and provided with a series of holes by which it may be locked in the required position to bring the locking pins in or out of contact.

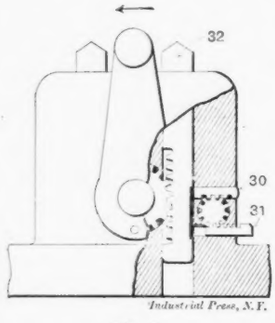


Fig. 3.

The power is transmitted from the variable feed mechanism through the telescopic shaft 33, Fig. 1, to the gear case 34. This case contains the feed reversing mechanism, which is operated by the lever 35, the movement of which serves to start, stop or reverse all feeds. The levers 36 and 37, Fig. 1, operate respectively the power vertical and the power transverse feeds. To guard against accidents or breakages, which are inherent in any positively driven mechanism, a safety screw is placed in the telescopic shaft 33, Fig. 1, which is intended to break under any unusual strain and prevent damage to the machine mechanism.

The feed tripping mechanism, shown in Fig. 3, is of the double plunger type, and embodies new features. It can be set to prevent the throwing in of the wrong clutch, is unusually sensitive, and when the feed is tripped, it is not necessary to run the table dog beyond the trip pin to reverse the feed, it being only required to reverse the tripping lever. The two stop pins 30 and 31 control the movement of the lever as follows: The plunger 32 has a recess for receiving the pins, so that when pin 30 is pushed in the lever can be moved only to the left, as the pin will come against the shoulder of the plunger and prevent its moving down; with the pin 31 pushed in, the shoulder at lower end of recess comes against the pin and allows the lever to be moved only to the right. When it is desired to feed the table in both directions, the pins are pushed in until both project an equal distance.

The table is heavy in proportion to the capacity of the machine, and provided with T slots sufficiently deep to insure strength. The arc through which the table can be swung is amply long; on the No. 2 machine, this arc is 286 degrees. The power feeds can be used with the table set at any angle to 53 degrees on the No. 2 machine, either side of zero.

The clamping arrangement for the overhanging arm is worthy of attention. One lever, 38, shown at the front of the machine, operates a shaft with rack teeth that engage the nuts on the clamping bolts, thus clamping both ends of the arm with one movement of the lever. The arm being a straight steel bar makes it possible to place any of the regular attachments in position without the necessity of removing the arm. Arm braces are furnished for tying the arm rigidly. The arbor support, beside carrying a bronze bushing for the arbor bearing, also carries an adjustable centre that is always in position.

BRIEF DESCRIPTIONS OF NEW TOOLS GROUPED FOR CONVENIENT REFERENCE.

The "American" grinding attachment for lathes made by L. S. Heald & Son., Barre, Mass., consists of a frame and swivel head carrying emery wheels of various sizes and shapes for grinding milling cutters, reamers, taps and similar tools. It is also very convenient for cylindrical and face grinding, and for internal grinding by the use of an extra pair of bevel gears, making altogether a handy and efficient machine on a great variety of work.

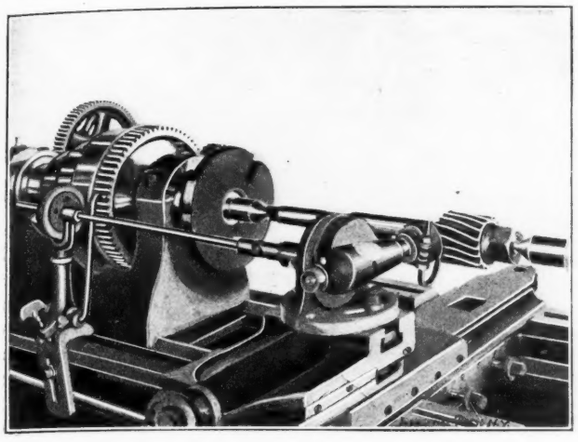


Fig. 1. L. S. Heald Grinding Attachment.

Power is obtained through a friction roll running on the largest step of the lathe cone, and transmitted to the grinding wheel through a universal joint and pair of bevel gears in the swivel head, one of which is made of fiber for quiet running. Various speeds for the grinding wheel are readily obtained by running the lathe belt on the different steps of the driving cone.

The illustrations, Figs. 1 and 2, show the grinder as applied to two different kinds of work. In Fig. 1 it is arranged for grinding an ordinary spiral cutter, placed on an arbor between the lathe centers. A cupped wheel on the end of the grinder spindle is used in this case and a lip rest is provided for the cutter teeth. In Fig. 2 the grinder is swiveled so that a small wheel can be used for internal grinding, the work being held in the chuck of the lathe. The wheel is on the end of an arbor fitted in the socket of the grinder

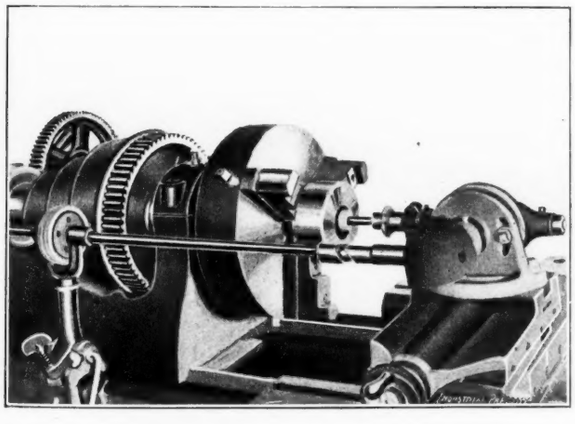


Fig. 2. Attachment Arranged for Internal Grinding.

spindle. Other photographs sent us, but not reproduced, show the attachment fitted for various other kinds of grinding, such as taper grinding, face grinding, sharpening formed cutters, etc.

The attachment is quite universal, as it will swing through various angles in both horizontal and vertical planes, and as everything about it is just as rigid as the lathe itself the operator is able to get just as good results as are possible in many cutter grinders, and at only a fraction of the expense for the machine.

HEAVY BORING, FACING AND TAPPING MACHINE.

The accompanying engraving illustrates an extra heavy and powerful design of a boring, facing and tapping machine that was recently brought out by Dreses, Mueller & Co., Cincinnati, Ohio. It does not differ radically from the ordinary upright drill press, except in its very heavy design for cutting holes in steel plates or bars, and for boring and facing pieces that cannot be put on a boring mill conveniently. There are also many instances where the machining to be done on a piece of work easily comes within the capacity of this machine, and yet the forging or casting is so large that if the work were done on a boring mill of the usual type it would tie up a large and expensive machine, having a swing of perhaps several feet.

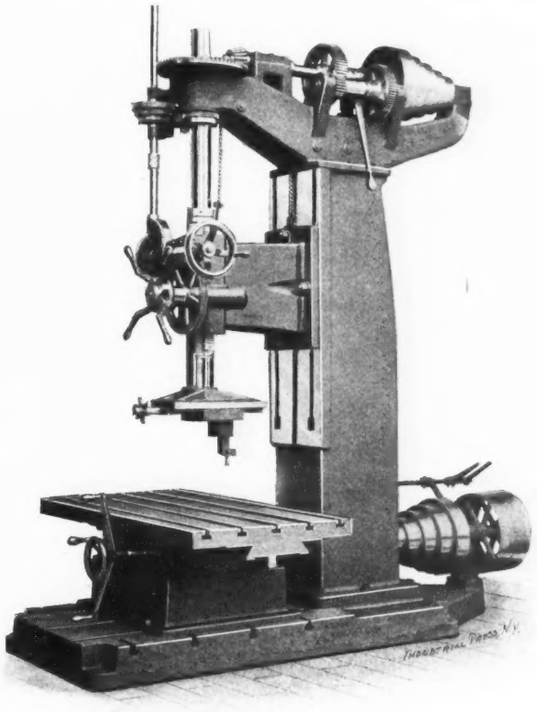


Fig. 3. Heavy Boring and Facing Machine.

The machine is provided with a compound table of a cross movement of 8 inches and a longitudinal movement of 40 inches. Both dimensions can, however, be changed to suit the nature of the work. The facing head has the well known star feed, and is provided with a tool clamp and holders to use ordinary square steel without forging it. The spindle is balanced, has quick return and power feed and the latter is so proportioned as to answer for both boring and drilling. The feed is varied by shifting the knob on the feed rod while the machine is running. The tool has ten speeds including the back gears and the latter can be made into the friction type with tapping attachment included.

The least diameter of the spindle is 3¼ inches, and the whole machine weighs 8,200 pounds.

NEW LINE OF TAPS.

In Fig. 4 is a cut of a new series of taps manufactured by Holroyd & Co., Waterford, N. Y. This tap is designed for use in turret lathes, and is a combined tap and drill; that is, it will drill and tap a hole at one operation, and in

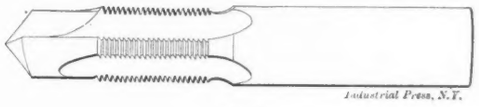


Fig. 4

cases where the hole is drilled clear through the piece, so that the drill will not have any cutting to do while the hole is being tapped, it is a very useful tool. It saves one space in the turret which can be utilized for an extra tool if desired, and also saves the time required to back out a drill, run

the turret back and advance the tap into the hole just drilled as is usually done. Several of these combined taps and drills have been used in different shops and have given excellent satisfaction.

WATER TOOL GRINDER, ELECTRICALLY DRIVEN.

Fig. 5 shows a photograph of a 20-inch electrical water tool grinder, manufactured by the Ransom Mfg. Co., Oshkosh, Wis. Power is furnished by a Northern Electric Co.'s motor which has the advantage that its brush end can be reached by raising the hood placed on the left-hand side and then simply pulling it off. Oiling devices are provided on the other side of the motor to obviate the necessity of taking off the hood.

The machine has an extra large bowl in front, and water is fed to the wheel by the water displacement plan, displacement being effected by adjusting a float by means of a hand-

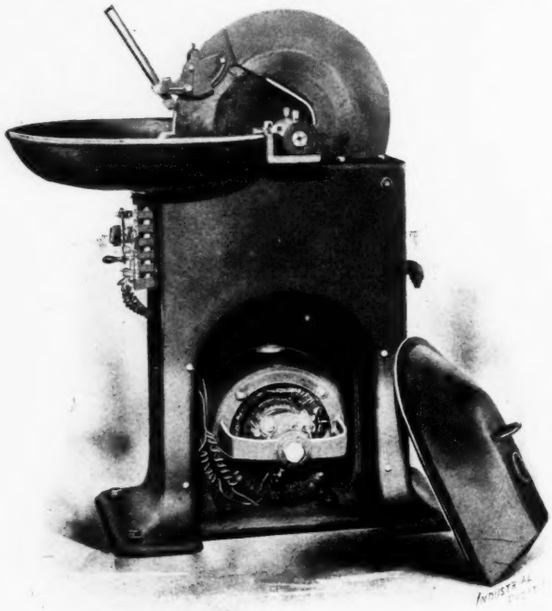


Fig. 5. Electrically driven Grinder.

wheel shown inside of the bowl. The float is of copper and will not rust. The journals for the emery wheel arbor are 9 inches in length and 1 9-16 inch in diameter, and are dust proof and ring oiling.

The grinder complete weighs 1,050 pounds; the emery wheel is 20 inches in diameter and 1½ inch thick.

STOCKING CUTTER.

Gould and Eberhardt, Newark, N. J., have placed on the market a new stocking cutter for use in gear cutting. It is a stepped stocking cutter for stocking out the teeth of gears before the finishing or final cut is taken, and it is recommended for 3 diametral pitch or coarser. A section of the cutting edge of one of these cutters is shown in Fig. 6, the dotted lines indicating the shape of a space between the teeth of the gear after the latter is completed. With the ordinary square blocking cutter a square or oblong section only is removed from the center of the tooth space, whereas the stepped cutter conforms more closely with the actual shape of the tooth space. The stepped shape of the cutter also breaks up the chips, and it is found that one of these cutters will remove as much stock at one operation as at two or three operations with the square cutters. This style of cutter is also considerably thicker through the hub than the ordinary cutter, which gives it a firmer support and prevents shearing off the keys.

Fig. 6.

NEW SKINNER PATTERN LATHE CHUCK.

In response to the demands of many foreign customers, the Skinner Chuck Co., New Britain, Conn., have brought out a new line of independent and combination lathe chucks having flush screws. Fig. 7 shows the face of a four-jawed independent chuck having flush screws, which is made in various sizes from 4-inch to 42-inch. Fig. 8 is the back of a three-jawed combination chuck having the same feature and made in sizes from 3-inch to 42-inch. The new chucks are made of the best materials (the old ones are, too) and are very strong, being even stronger than the old line having projecting screws, because the chuck bodies for chucks having the same

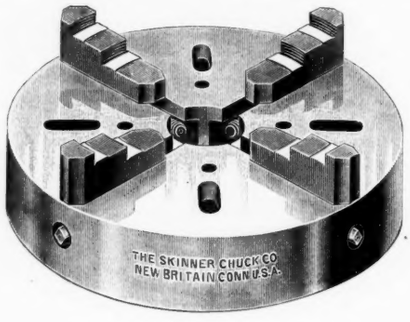


Fig. 7.

swing have been enlarged sufficiently to encompass the screws. Thus chucks of the same swing, whether of the old or new lines, will swing in the same circles. The faces of the bodies are ground to a perfectly true surface, and the jaws accurately fitted. The jaws are case-hardened and ground. They are steel drop-forgings, have a full nut, and are reversible in all sizes. The combination chuck is made with two, three

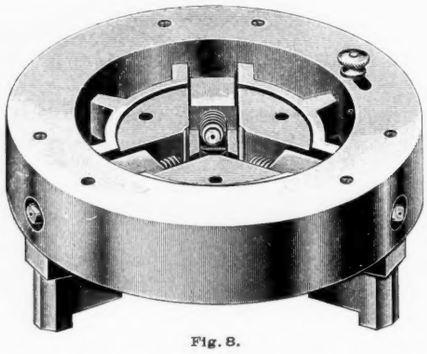


Fig. 8.

and four jaws. While a flush-jaw chuck has its disadvantages, it is somewhat safer to use than the projecting-screw chuck, and for that reason is preferred by some workmen. These chuck users, therefore, will be pleased to know of this new line of Skinner chucks.

NEW SHOP SAW.

H. T. Story, 18-30 West Randolph St., Chicago, Ill., has brought out a draw-cut machine saw designed for work of large size. The vise jaws are 7 inches wide, 6 inches high and open 11 inches and are actuated by right-and-left-hand screw,

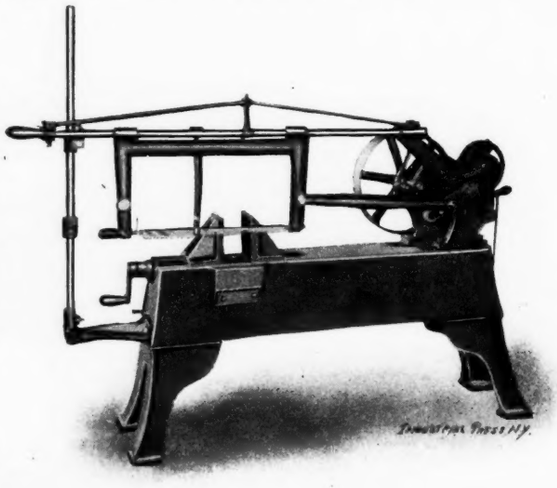


Fig. 9. Draw-cut Saw.

BROWN & SHARPE MFG. CO.

Brown & Sharpe Mfg. Company,

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1367.

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More than One Hundred different styles carried in stock.

A Micrometer can be selected for almost any purpose from those listed in our 1902 Catalog, which is mailed to any address upon application.

Leading Hardware Dealers carry our Tools in stock.

MICROMETER CALIPERS.

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one inch in diameter with adjusting collar for taking up wear. The driving pulley is 16 inches in diameter, 3 inch-face, and is geared so that it runs about three times as fast as the crank operating the saw. Cutting takes place on the inward or draw stroke. These two features enable rapid and smooth work to be done without danger of breaking the blade or of stalling the machine when sawing hard metal. The saw blade lifts on the return stroke and has a combined power and gravity feed, with automatic throw out. The cut can be stopped at any desired point by clamping a split collar on the upright at the left of the machine, Fig. 9, which will thus stop the downward travel of the frame when the latter comes in contact with the collar. The length of stroke is adjustable and the saw blade is guided by rollers to ensure a straight cut.

The guides carrying the saw frame may be raised to any desired height and set from the front end of the machine. The rod which controls the feed cam is within easy reach of the operator.

The jaws and screw of the vise may be entirely removed from the bed when extra large or odd-shaped pieces are to be cut. The machine requires a 20-inch blade, No. 14 gage, or heavier if desired. The machine should make about 25 strokes per minute. It will be supplied either mounted on a simple box bed, or with bed mounted on legs, as may be wanted. It is also made both right- and left-hand, to enable two machines to be set together in pairs, so that two cuts may be in progress on the same piece of stock at the same time.

A SPEED "VARIATOR."

A variable speed device has been placed on the market by the Lodge and Shipley Machine Tool Co., Cincinnati, O., which, in its present form is designed for use as a countershaft for driving lathes and other machine tools. The arrangement of the apparatus may be so changed, however, as to enable its use for any purpose where a change in speed is required between wide limits.

The general principle of the device is the familiar one of two sets of gears, arranged in cones on parallel shafts. The driving shaft is at *A*, Fig. 10, and all gears constituting the driving cone are keyed securely to this shaft. The driven shaft is at *B* and carries a similar cone of gears, all of which are loose upon the shaft with the exception of the one through which power is being transmitted at any given time. The distinctive feature of this variable speed device is the method employed for causing the different loose gears to mesh with the corresponding gears on the driving shaft and to thus drive the driven shaft *B* at a corresponding speed.

In most mechanisms of the kind all the loose gears are in mesh with the driving gears all the time, so that all rotate at their respective speeds without regard to which gear is carrying the load. In this device the loose gears are bored out larger than the diameter of the shaft *B*, and when not in action drop out of mesh and simply hang suspended with their teeth just out of contact with the teeth of the driving gears. The hubs of the loose gears are long enough so that when the gears have dropped out of mesh the hubs will be supported upon the separating pieces *C*, *C*, and keep the top surfaces of the bore of the gears from rubbing on the rotating shaft.

The loose gears are bushed with steel bushings and the inside edges of the bushings are beveled as shown in the illustration. On shaft *B* is a collar, fast to the shaft, the outside diameter of the collar being equal to the inside diameter of the gear bushings. The edges of the collar are beveled to correspond to the beveled edges of the bushings, and it is evident that by giving shaft *B* an endwise motion each gear upon the shaft will be raised in turn from the supports *C C*, and will be brought into mesh with the corresponding driving gear. This is what is actually done in changing the speed. The shifter has a fork at its upper end which can be made to engage annular grooves in shaft *B*, spaced at regular intervals, so that when the shifter has been moved its full distance the collar on shaft *B* will be brought exactly at the middle of one of the gears.

At *D* in the illustration, a gear is shown raised into position for driving shaft *B*, and the same thing is also shown in the enlarged view, which more clearly illustrates the method for keying the gear to the shaft so that the latter will have to turn with it. A key with beveled ends is used and is forced into the keyway in the hub of the gear by a spring.

A clutch, indicated in the illustration, is operated automatically when the shifter engages or disengages the fork. This prevents shock arising from sudden change of speed. The reversal of motion is obtained by the taper friction pulley *G* engaging the taper friction surfaces of the belt pulleys *F F*. The pulley *G* is shifted one way or the other by moving a collar at the right hand end of shaft *A*, until one of the set screws *K K* causes the rocker *I* to tilt one way or the other. This in turn slides the key *H*, which moves pulley *G*. This reversal is accomplished by a shifter operating on the collar.

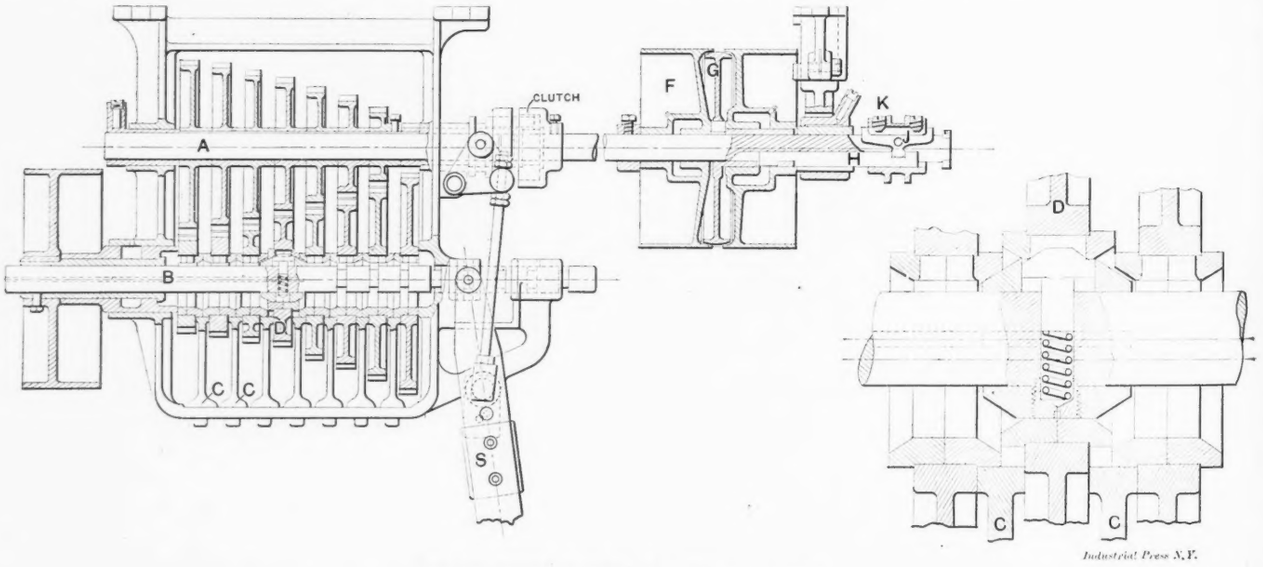


Fig. 10. Details of Variable Speed Countershaft.

CORRECTION.

In the article in the last number describing the automatic multiple spindle drill press, manufactured by the National Automatic Tool Co., Dayton, O., it was inadvertently stated that it will take drills up to 5-16 inch in diameter. The machine is of much larger capacity than that and will take drills up to $\frac{5}{8}$ inches in diameter.

* * *

ADVERTISING LITERATURE.

We have received the following catalogues and trade circulars:

THE CHICAGO HOUSE WRECKING CO., Chicago, Ill. Pamphlet containing a list of the materials furnished by this company for the various buildings at the Pan-American Exposition. The list is a long one and includes a great variety of materials.

E. G. SMITH, Columbia, Pa., who manufactures machinists' tools, has made somewhat of a departure by arranging to supply timepieces in the form of tall clocks for machinists and others who appreciate accurate time-keepers. They are made to sell at a comparatively low price.

THE AMERICAN BLOWER CO., Detroit, Mich. Illustrated catalogue of steel plate fans. The fans and apparatus described are for ventilating purposes and there are a number of useful details in the catalogue relating to the sizes and capacities of the fans, and it also contains data of value to one having calculations to make.

THE CLEVELAND TWIST DRILL CO., Cleveland, O. Catalogue of drills, reamers and similar tools, comprised in the large line manufactured by this company. In addition to these regular tools we note several novelties, such as their improved drill sockets, an adjustable snap gage, drill chucks, punches and dies, etc.

THE BINSSE MACHINE CO., Newark, N. J. Illustrated catalogue of the horizontal boring machine made by this company, with illustrations showing the various ways in which it may be used for boring and milling. The catalogue is entitled, "The Tool for Precision in Boring," since it is especially designed for accurate boring and drilling, such as is required in jig-work, as well as in heavier pieces.

BLAKE & JOHNSON, Waterbury, Conn. Illustrated catalogue of machines for operating on sheet metal and wire, as well as machine tools and other metal working machinery. Space does not permit a complete list of all the machines manufactured, but they include rolling mills, metal slitting machines, punches and drop presses, dropping hammers, thread rolling machines, spinning lathes, milling machines, etc.

THE CINCINNATI MILLING MACHINE CO., Cincinnati, O. Illustrated catalogue of milling machines and attachments and cutter and tool grinders. This is a standard size catalogue of 90 pages and is one of the most attractive in appearance that has been received at this office. Appearance is not sacrificed to utility, however, and the explanations of the various features of these milling machines and of the uses to which the attachments can be applied are exceptionally lucid, with plenty of illustrations and clearly written text. It is a book that should be in the hands of everybody interested in milling machines.

MANUFACTURERS' NOTES.

One of the most recent productions of the Lunkenheimer Co., Cincinnati, O., is an improved blow-off valve for steam boilers. The novel feature of this valve is the arrangement for blowing off the valve seat, so that it will be free from scale, sediment or dirt just before the disk is seated. This prevents cutting the seat and ensures that the valve will remain tight. Blow-off valves probably give more trouble than any of the fittings that go to make up a boiler equipment; and in producing this valve the Lunkenheimer Co. have done away with the objectionable features which cause so much trouble in the ordinary type of valve. The valves can also be easily reseated by replacing the casing when worn.

MR. EDGAR H. BERRY, recently draftsman in charge of the equipment department of the Navy Yard, Brooklyn, N. Y., has resigned his position at the Navy Yard to enter the employ of the C. W. Hunt Co., West Brighton, N. Y.

THE CHAPIN-LOVE MACHINE CO. 129-133 Worth St., New York, have bought out the business and machine shop of the D'Amour & Littledale Machine Co., and will continue the business of machinists and tool-makers, building a line of drills from 6 to 14 inches, with 1 to 6 spindles.

CHARLES H. BESLY & CO., 10-12 N. Canal St., Chicago, Ill., report that they are receiving many orders for their Gardner grinder with spiral-grooved disks, recent shipments having been made to California, Washington, Oregon, Wisconsin, Ohio and Pennsylvania. They have also numerous orders from the Coast for their Helmet oil, and Badger and Bonanza cups. The late edition of their general catalogue, with discount sheet, will be mailed free to any address upon application.

THE DAVISON MFG. CO., 112 Front St., Brooklyn, N. Y., are manufacturing a very neat charm for machinists to wear on their watch chains in the shape of a very perfectly made monkey wrench. It is of German silver with the movable jaw operated by a minute screw on the same principle as in the large wrenches. The handle is of different material, held in place by a tiny nut on the end of the handle. These are made in large quantities to sell at a low figure and are an interesting example of machine work.

THE BUFFALO FORGE CO., Buffalo, N. Y., are in receipt of a letter from William Garstang, Superintendent of Motive Power for the "Big Four Route" R. R. Co., endorsing the down-draft forges which they manufacture. Mr. Garstang writes: "We consider your down-draft system an excellent one, first, on account of the thoroughness in removing smoke from the shop, and, second, on account of not requiring overhead pipe or other obstructions to interfere with or prevent the handling of heavy work with cranes, etc."

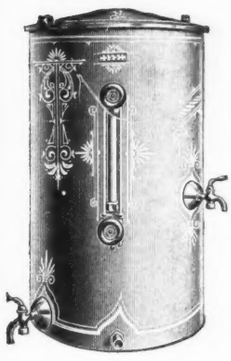
THE CLING-SURFACE MFG. CO., Buffalo, N. Y., recently received at their New York branch a letter from the Williamsport branch of the American Woodworking Machinery Co., which reads in part as follows: "We have three belts in our factory, 8, 10 and 12 inches wide, running on iron pulleys, that were causing us a great deal of trouble and annoyance by constantly slipping. We have treated these three belts according to directions and we are glad to report that we are now running them very slack and the slipping has entirely disappeared. The iron pulleys that would become so hot you could hardly touch them are now running cool. We are to-day recommending this preparation to another plant."

THE ROYERSFORD FOUNDRY & MACHINE CO. Royersford, Pa., report a very active business in the punch and shear line. They have many orders, and prospects for the future are very bright. They have added several new machines and are now prepared to fill orders more promptly than ever before. The demand for their punches and shears is increasing continually. They have recently shipped cut machines to the following parties: The Prentiss Tool & Supply Co., New York, N. Y.; F. R. Patch Mfg. Co., Rutland, Vt.; the Westmoreland Steel & Mfg. Co., Huff, Pa.; the Anthracite Separator Co., Hazleton, Pa.; H. Channon Co., Chicago, Ill.

THE ARMSTRONG BROS. TOOL CO., Chicago, Ill., report a marked increase recently in the export demand for their tool holders. They have recently established agencies in Australia and New Zealand and also in Norway, Sweden and Denmark through the firm of C. S. Christensen, of Christiania, Norway. Mr. Nestor Johnson was recently sent to these countries by the Armstrong Co. for the purpose of establishing agencies there for the introduction of the Armstrong tools. The Armstrong Co. inform us that numerous large orders for Armstrong tools and self-hardening steel have been sent in subsequently by C. S. Christensen, testifying to the success attending Mr. Johnson's trip.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., in the February number of its handbook, describes in an interesting way the plan of the School for enabling mechanics and others to improve their education without taking time from their work. The School offers courses in mechanical, electrical, steam and textile engineering. Several pages of the handbook, showing actual work done by students, are printed in two colors, the student's work in black and the instructor's corrections in red, giving an excellent idea of the method of teaching. The American School of Correspondence have also sent us the name of one of their former students, Mr. Frank O. Hubbard, of Chicago, who recently completed the course in stationary engineering at the School and received his diploma, and who is now in the employ of Marshall, Field & Co. as electrician.

The Big Locomotive Works all use Warden Filters



The Baldwin Works of Philadelphia recently sent us their EIGHTH order, and the American Locomotive Co. their THIRD order.

The manufacture of Locomotives is one of the most profitable branches of industry in the country—every concern in that business is running full time, away behind their orders, and all making money; but notwithstanding that, they dont propose to let any dollars slip by that they can save, and they save a lot of them by passing their dirty oil through the Warden Filter, bringing it out as fresh and clean as new.

Are any of your dollars slipping away in your oil?

If so, try a Warden Filter at our risk.

Shelby & Co., London, E. C., Eng., Sole Agents for Great Britain.

The Burt Mfg. Co.

Main & Howard Sts., Akron, O., U.S.A.

THE BURT EXHAUST HEAD

is the result of years of practical experience with all the useful and useless adjuncts of an Exhaust Head. All those that add to the expense and detract from the efficiency have been discarded; and the good, the practical, the simple, the efficient are embodied in the Burt. The best is cheapest in the end. Sold on the same guarantee as our filters.

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M. H. TREADWELL & Co., 95 Liberty St., New York, have closed a contract with the Sharon Steel Co., Sharon, Pa., for supplying portions of the equipment and materials for four 50-ton basic open-hearth furnaces.

THE IROQUOIS MACHINE Co., 150 Nassau St., New York, has just been incorporated as a New York company, having been organized by W. W. Gibbs, president of the Kidder Press Co. and a member of the Gibbs-Blower Co. The officers of the Iroquois Co. are: Edwin A. Smith, President; W. W. Gibbs, Vice-President and General Manager; and Henry C. Babcock, Secretary and Treasurer. The company will manufacture new and improved wire-drawing machinery, also a full line of automatic and plain drop hammers, swaging machines, rolling mills, roller bearings and grinding machines.

THE REEVES PULLEY Co., Columbus, Ind., have just published a revised edition of their pocket memorandum book, descriptive of the "Reeves" variable speed transmission. A number of valuable tables have been added and others changed. It includes also several pages of matter entirely new, of interest to the paper mill industry. The booklet is neatly bound in leather, gold edge, and has been compiled with especial reference to the interest of the practical mechanic and mill superintendent, who have to do with the installation and operation of the "Reeves" variable speed transmission. One hundred double-ruled linen blank pages are also included for memoranda. This book will be mailed prepaid upon receipt of 15 cents in silver or stamps. Address the Catalogue Department, Reeves Pulley Company, Columbus, Ind.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order.

POSITION WANTED—Designer and draftsman of special and automatic machinery, jigs, fixtures, etc; ten years' practical experience, including two and one-half years' shop practice. Address D., care MACHINERY, 9-15 Murray St., New York.

SPECIAL TOOLS, models, fine light machinery and foundry work wanted. MURRAY MFG. CO., Richmond Valley, Staten Island, N. Y.

GAS ENGINE FOR SALE—Used less than a dozen times. One-half. H. P.; made by Backus Water Motor Co. Address, "ENGINE," care of MACHINERY, 9-15 Murray St., New York.

WANTED—Position as foreman machine shop by capable mechanic, twenty-three years' experience (foreman four years); sober and industrious. Address B, care MACHINERY, 9-15 Murray St., New York.

WANTED—Position as master mechanic or superintendent, light machinery or manufacturing, by man of 35 years, well up in methods to produce parts at minimum cost, or to take charge of an imperfect invention requiring deep study to perfect. Good reference from present concern. Address M. M., care MACHINERY, 9-15 Murray St., New York.

ENGINEERS, Firemen, Machinists and Electricians send for 40-page pamphlet containing questions asked by Examining Board of Engineers to obtain engineers' license. Address GEO. A. ZELLER, Publisher, Room 585, No. 18 So. 4th Street, St. Louis, Mo.

WANTED—Machinists and Die Makers; state wages and experience. Address THE BUESCHER MFG. CO., Elkhart, Ind.

INVENTOR'S MODELS built and perfected, special machinery designed and built, small parts duplicated. Let us quote prices. F. J. STOKES MACHINE CO., Philadelphia, Pa.; New York representative, FRANK P. WISNER, 101 Beekman St.

WANTED—Machinists accustomed to accurate work. Good wages and steady employment to the right men. LELAND AND FAULCONER MFG. CO., Detroit, Mich.

TEACHERS WANTED.—Manual Training, carpentry or iron work, for High Schools and Academies; good salaries. $800 to $1,600. Vacancies now for September. Registration *free* because of the demand. Address ANNA M. THURSTON, Thurston Teachers' Agency, 378 Wabash Ave., Chicago, Ill.

PATENTS—Send no money but a model or drawing with a description, and we will advise you. J. S. DUFFIE & CO. (Dept. B.), Washington, D. C. Free.

First Cost, or Wages?

The first cost of our tools is more, we believe, than of any others. We want it to be more. Everything must be the best,—the costliest material, the highest-priced labor. We stint in nothing.

It's after our tools are at work that their cheapness shows. You'll quickly find it in your pay-roll, your cost-cards, and your repair-bills.

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